CHAPTER - 1

ECOLOGY

Ecology 'Oikos' meaning home or place to live in and 'logos' meaning study. Literally it is the study of the home of nature.

Ecology is defined "as a scientific study of the relationship of the living organisms with each other and with their environment."

It deals with the ways in which organisms are moulded by their environment, how they make use of environmental resources including energy flow and mineral cycling.

1.1. HISTORY OF ECOLOGY

The roots of ecology lie in Natural History, which is as old as human civilization itself. Since early history, man has indulged in ecology in a practical sort of way, knowingly and unknowingly. In primitive societies every individual was required to have an intimate knowledge of his environment for their survival, i.e., about the forces of nature and of plants and animals around him/her.

Our ancient Indian texts have references to ecological principles. The classical texts of the Vedic period such as the Vedas, the Samhitas, the Brahmanas and the Aranyakas-Upanishads contain many references to ecological concepts.

The Indian treatise on medicine, the Charaka-Samhita and the surgical text Sushruta-Samhita, show that people during this period had a good understanding of plant and animal ecology.

These texts contain classification of animals on the basis of habit and habitat, land in terms of nature of soil, climate and vegetation; and description of plants typical to various localities. Charaka- Samhita contains information that air, land, water and seasons were indispensable for life and that polluted air and water were injurious to health.

1.2. ENVIRONMENT AND ITS COMPONENT

Everything that surrounds or affects an organism during its life time is collectively known as its environment.

The environment is defined as 'the sum total of living, non-living components; influences and events, surrounding an organism.

All organisms (from virus to man) are obligatorily dependent on the other organism and environment for food, energy, water, oxygen, shelter and for other needs.

The relationship and interaction between organism and environment are highly complex. It comprises both living (biotic) and non-living (abiotic) components.

The environment is not static. Both biotic and abiotic factors are in a flux and keeps changing continuously.

Components of Environment

Abiotic	Biotic
Energy	Green plants
Radiation	Non-green plants
Temperature & heat flow	Decomposers
Water	Parasites
Atmospheric gases and wind	Symbionts
Fire	Animals
Gravity	Man
Topography	
Soil	
Geologic substratum	

For instance: Let's take the environment of a fish in the pond.

External environment of fish

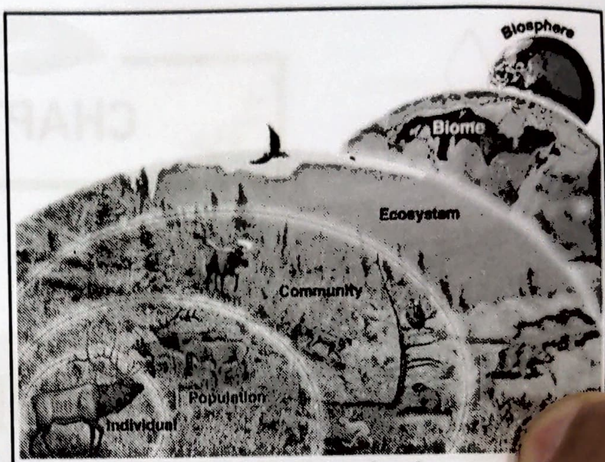
- Its environment consists of abiotic components such as light, temperature, including the water in which nutrients, oxygen, other gases and organic matter are dissolved.
- The biotic environment consists of microscopic organisms called plankton which it assume as well as aquatic plants, animals and decomposers.

Internal environment of fish

- It is enclosed by the outer body surface.
- The internal environment is relatively stable as compared to the external environment.
- However, it is not absolutely constant. Injury, illness or excessive stress upsets the internal environment.
- For example, if a marine fish is transferred to a fresh water environment, it will not be able to survive.

1.3. LEVELS OF ORGANISATIONS IN ECOLOGY

The main levels of organisation of ecology are six and are as follows.



Ecological Organisation

1.3.1. Individual

Organism is an individual living being that has the ability to act or function independently. It may be plant, animal, bacterium, fungi, etc. It is a body made up of organs, organelles, or other parts that work together to carry out on the various processes of life.

1.3.2. Population

Population is a group of organisms usually of the same species, occupying a defined area during a specific time.

Population growth rate is the percentage variation between the number of individuals in a population at two different times. Therefore the population growth rate can be positive or negative.

Population density is the relation between the number of individuals of a population and the area they occupy.

The main factors that make population increase are birth and immigration. The main factors that make population decrease are death and emigration.

The main limiting factors for the growth of a population are abiotic and biotic components.

1.3.3. Community

If we look around ourself, we will notice that population of plants and animals seldom occur by themselves. The reason for this is quite obvious. In

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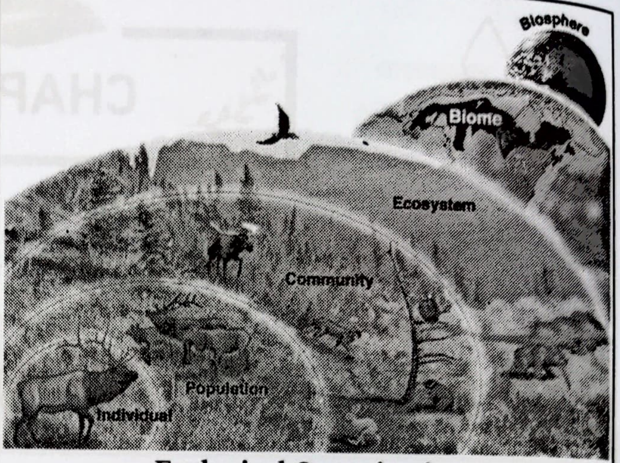

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1.3.3. Community

If we look around ourself, we will notice that population of plants and animals seldom occur by themselves. The reason for this is quite obvious. In order to survive, individuals of any one species depend on individuals of different species with which they actively interact in several ways.

Communities in most instances are named after the dominant plant form (species).

For example: A grassland community is dominated by grasses, though it may contain herbs, shrubs, and trees, along with associated animals of different species.

A community is not fixed or rigid; communities may be large or small.

Types of Community

On the basis of size and degree of relative independence communities may be divided into two types:

(a) Major Community

These are large-sized, well organized and relatively independent. They depend only on the sun's energy from outside and are independent of the inputs and outputs from adjacent communities.

E.g: tropical ever green forest in the North-East

(b) Minor Communities

These are dependent on neighbouring communities and are often called societies. They are secondary aggregations within a major community and are not therefore completely independent units as far as energy and nutrient dynamics are concerned. e.g: A mat of lichen on a cow dung pad.

Structure of a community

In a community the number of species and size of their population vary greatly. A community may have one or several species.

The environmental factors determine the characteristic of the community as well as the pattern of organisation of the members in the community.

The characteristic pattern of the community is termed as structure which is reflected in the roles played by various population, their range, the type of area they inhabit, the diversity of species in the community and the spectrum of interactions between them.

1.3.4. Ecosystem

An ecosystem is defined as a structural and functional unit of biosphere consisting of community of living beings and the physical environment, both interacting and exchanging materials between them.

It includes plants, trees, animals, fish, birds, micro-organisms, water, soil, and people.

Ecosystems vary greatly in size and elements but each is a functioning unit of nature. Everything that lives in an ecosystem is dependent on the other species and elements that are also part of that ecological community. If one part of an ecosystem is damaged or disappears, it has an impact on everything else.

When an ecosystem is healthy (i.e. sustainable) it means that all the elements live in balance and are capable of reproducing themselves. Ecosystem can be as small as a single tree or as large as entire forest.

Difference between ecology, environment and ecosystem

For example, let us take Shankar IAS Academy and its students. Let's say that ecology would be the scientific study of student's relationship with the Shankar IAS Academy as a whole. The Shankar IAS Academy being the environment in which the student studies, and the set of circumstances surrounding the student in which environment would be the teachers, books, other students, etc are said to be ecosystem.

Components of Ecosystem

The components of ecosystem and environment are same.

1. Abiotic Components

Abiotic components are the inorganic and non-living parts of the world. The abiotic part consists of soil, water, air, and light energy etc. It also involves chemicals like oxygen, nitrogen etc. and physical processes including volcanoes, earthquakes, floods, forest fires, climates, and weather conditions.

Abiotic factors are the most important determinants of where and how well an organism exists in its environment. Although these factors interact with each other, one single factor can limit the range of an organism.

a) Energy

Energy from the sun is essential for maintenance of life. In the case of plants, the sun directly supplies the necessary energy. Since animals cannot use solar energy directly they obtain it indirectly by eating plants or animals or both. Energy determines the distribution of organisms in the environment.

b) Rainfall

Water is essential for all living beings. Majority of biochemical reactions take place in an aqueous medium. Water helps to regulate body temperature. Further, water bodies form the habitat for many aquatic plants and animals.

c) Temperature

Temperature is a critical factor of the environment which greatly influences survival of organisms. Organisms can tolerate only a certain range of temperature and humidity.

d) Atmosphere

The earth's atmosphere is responsible for creating conditions suitable for the existence of a healthy biosphere on this planet.

e) Substratum

Land is covered by soil and a wide variety of microbes, protozoa, fungi and small animals (invertebrates) thrive in it. Roots of plants pierce through the soil to absorb water and nutrients. Organisms can be terrestrial or aquatic. Terrestrial animals live on land. Aquatic plants, animals and microbes live in fresh water as well as in the sea. Some microbes live even in hot water vents under the sea.

f) Materials:

(i) Organic compound such as proteins, carbohydrates, lipids, humic substances are formed from inorganic compound on decomposition.

(ii) Inorganic compound such as carbon dioxide, water, sulphur, nitrates, phosphates, and ions of various metals are essential for organisms to survive.

g) Latitude and altitude

Latitude has a strong influence on an area's temperature, resulting in change of climates such as polar, tropical, and temperate. These climates determine different natural biomes.

From sea level to highest peaks, wild life is influenced by altitude. As the altitude increases, the air becomes colder and drier, affecting wild life accordingly.

2. Biotic Components

Biotic components include living organisms comprising plants, animals and microbes and are classified according to their functional attributes into producers and consumers.

a) Primary producers - Autotrophs (self-nourishing)

- Primary producers are basically green plants (and certain bacteria and algae).
- They synthesise carbohydrate from simple inorganic raw materials like carbon dioxide and water in the presence of sunlight by the process of photosynthesis for themselves, and supply indirectly to other non-producers.
- In terrestrial ecosystem, producers are basically herbaceous and woody plants, while in aquatic ecosystem producers are various species of microscopic algae.

b) Consumers – Heterotrophs or phagotrophs (other nourishing)

- Consumers are incapable of producing their own food (photosynthesis).
- They depend on organic food derived from plants, animals or both.
- Consumers can be divided into two broad groups namely micro and macro consumers.

(i) Macro consumers

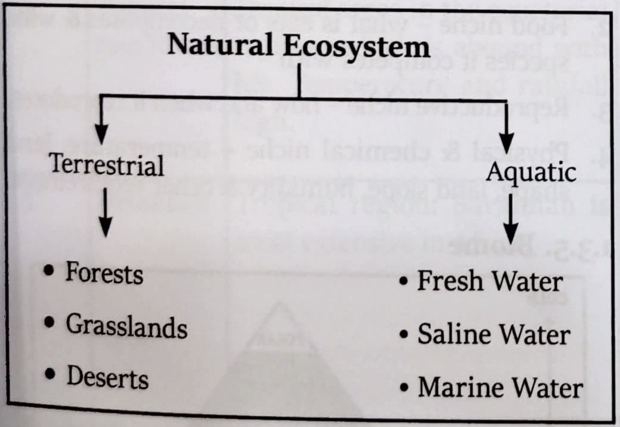
- They feed on plants or animals or both and are categorised on the basis of their food sources.

- Herbivores are primary consumers which feed mainly on plants e.g. cow, rabbit.
- Secondary consumers feed on primary consumers e.g. wolves.
- Carnivores which feed on secondary consumers are called tertiary consumers e.g. lions which can eat wolves.
- Omnivores are organisms which consume both plants and animals e.g. man, monkey.

(ii) Micro consumers - Saprotrophs (decomposers or osmotrophs)

- They are bacteria and fungi which obtain energy and nutrients by decomposing dead organic substances (detritus) of plant and animal origin.
- The products of decomposition such as inorganic nutrients which are released in the ecosystem are reused by producers and thus recycled.
- Earthworm and certain soil organisms (such as nematodes, and arthropods) are detritus feeders and help in the decomposition of organic matter and are called detrivores.

Classification of Eco-system:



The detailed study of ecosystem will be dealt in the subsequent chapters.

Ecosystems are capable of maintaining their state of equilibrium. They can regulate their own species structure and functional processes. This capacity of ecosystem of self regulation is known as **homeostasis.**

Goods and Services provided by ecosystems include:

- Provision of food, fuel and fibre
- Provision of shelter and building materials
- Purification of air and water
- Detoxification and decomposition of wastes
- Stabilization and moderation of the Earth's climate
- Moderation of floods, droughts, temperature extremes and the forces of wind.
- Generation and renewal of soil fertility, including nutrient cycling.
- Pollination of plants, including many crops Control of pests and diseases
- Maintenance of genetic resources as key inputs to crop varieties and livestock breeds, medicines, and other products
- Cultural and aesthetic benefits

Ecological Footprint

The "ecological footprint" is a measure of human demand on the Earth's ecosystems. It is a standardized measure of demand for natural capital that may be contrasted with the planet's ecological capacity to regenerate and represents the amount of biologically productive land and sea area necessary to supply the resources a human population consumes, and to assimilate associated waste.

Currently, humanity's total ecological footprint is estimated at 1.5 planet Earths—in other words, humanity uses ecological services 1.5 times as fact as Earth can renew them.

The "carbon footprint" is the amount of carbon being emitted by an activity or organization. The carbon component of the ecological footprint converts the amount of carbon dioxide being released into the amount of productive land and sea area of carbon dioxide being released into the amount of productive land and sea area required to sequester it and tells the demand on the Earth that results from burning fossil fuels.

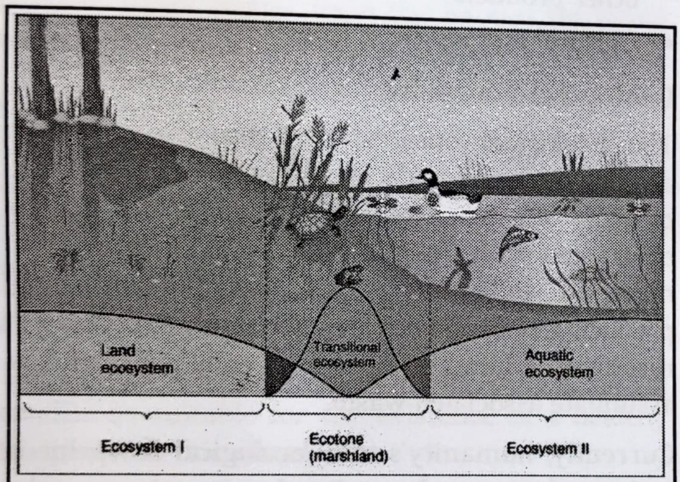
The carbon footprint is 54% of the ecological footprint and its most rapidly-growing component having increased 11-fold since 1961.

Global Footprint Network (GFN) every year presents a report on ecological footprint which maps consumption and requirement of natural resources to sustain it. Lifestyle adopted in developed countries is unsustainable and it will require five Earths to fulfil their lifestyle demands.

On the other hand, Indian lifestyle is sustainable where one earth is sufficient. The Earth Overshoot Report has indicated that the Ecological Footprint of developed countries ranges from 8 to 4 whereas India is at 0.9.

Ecotone

Ecotone is a zone of junction between two or more diverse ecosystems. For e.g. the mangrove forests represent an ecotone between marine and terrestrial ecosystem. Other examples are – grassland, estuary and river bank



Ecotone

Characteristics of Ecotone

- It may be very narrow or quite wide.
- It has the conditions intermediate to the adjacent ecosystems. Hence it is a zone of tension.
- It is linear as it shows progressive increase in species composition of one in coming community and a simultaneous decrease in species of the other out going adjoining community.
- A well developed ecotones contain some organisms which are entirely different from that of the adjoining communities.
- Sometimes the number of species and the population density of some of the species is much greater in this zone than either community. This is called edge effect.

The organisms which occur primarily or most abundantly in this zone are known as edge species. In the terrestrial ecosystems edge effect is especially applicable to birds.

For example the density of birds is greater in the mixed habitat of the ecotone between the forest and the desert.

Niche

A niche is the unique functional role or place of a species in an ecosystem. It is a description of all the biological, physical and chemical factors that a species needs to survive, stay healthy and reproduce.

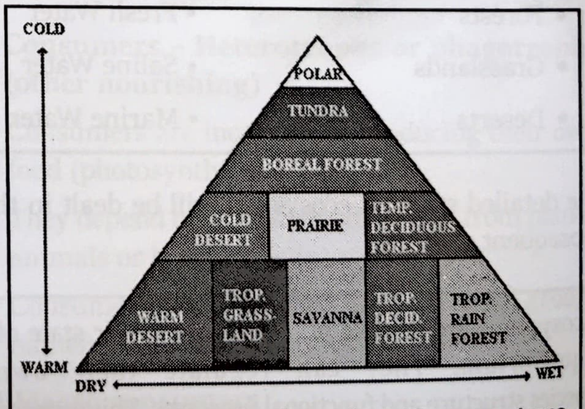
A niche is unique for a species, which means no two species have exact identical niches. Niche plays an important role in conservation of organisms.

If we have to conserve species in its native habitat we should have knowledge about the niche requirements of the species and should ensure that all requirements of its niche are fulfilled.

Types of Niche

1. Habitat niche – where it lives
2. Food niche – what is eats or decomposes & what species it competes with
3. Reproductive niche – how and when it reproduces.
4. Physical & chemical niche – temperature, land shape, land slope, humidity & other requirement.

1.3.5. Biome



BIOME Distribution based on Temperature and Precipitation

The terrestrial part of the biosphere is divisible into enormous regions called biomes, which are characterized, by climate, vegetation, animal life and general soil type.

No two biomes are alike. The climate determines the boundaries of a biome and abundance of plants and animals found in each one of them. The most important climatic factors are temperature and precipitation.

S.No.	Name of Biome	Region	Flora and Fauna
1	Tundra	Northern and Southern most region of world adjoining the ice bound poles	Devoid of trees except stunted shrubs in the southern part of tundra biome, ground flora includes lichen, mosses and sedges. The typical animals are reindeer, arctic fox, polar bear, snowy owl, lemming, arctic hare, ptarmigan. Reptiles and amphibians are almost absent.
2	Taiga	Northern Europe, Asia and North America. Moderate temperature than tundra. Also known as boreal forest.	The dominating vegetation is coniferous evergreen mostly spruce, with some pine and firs. The fauna consists of birds, hawks, fur bearing carnivores, little mink, elks, puma, Siberian tiger, wolverine, wolves etc.
3	Temperate Deciduous Forest	Extends over Central and Southern Europe, Eastern North America, Western China, Japan, New Zealand etc. Moderate average temperature and abundant rainfall.	The flora includes trees like beech, oak, maple and cherry. Most animals are the familiar vertebrates and invertebrates. These are generally the most productive agricultural areas of the earth
4	Tropical rain forest	Tropical areas in the equatorial regions, which is abound with life. Temperature and rainfall high.	Tropical rainforest covers about 7% of the earth's surface & 40% of the world's plant and animal species. Multiple storey of broad-leafed evergreen tree species are in abundance. Most animals and epiphytic plants are concentrated in the canopy or tree top zones.
5	Savannah	Tropical region: Savannah is most extensive in Africa.	Grasses with scattered trees and fire resisting thorny shrubs. The fauna include a great diversity of grazers and browsers such as antelopes, buffaloes, zebras, elephants and rhinoceros; the carnivores include lion, cheetah, hyena; and mongoose, and many rodents.
6	Grassland	North America, Ukraine, etc. Temperate conditions with low rainfall.	Grasses dominate the vegetation. The fauna include large herbivores like bison, antelope, cattle, rodents, prairie dog, wolves, and a rich and diverse array of ground nesting bird.
7	Desert	Continental interiors with very low and sporadic rainfall with low humidity. The days are very hot but nights are cold.	The flora is drought resistance such as cactus, euphorbias, sagebrush. Fauna: Reptiles, Small Mammals and birds.

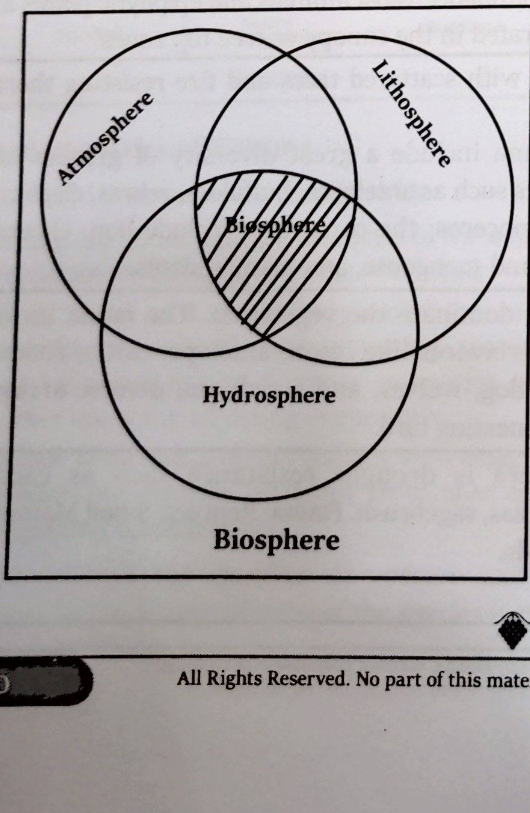
Aquatic Zones

Aquatic systems are not called biomes, however they are divided into distinct life zones, with regions of relatively distinct plant and animal life. The major differences between the various aquatic zones are due to salinity, levels of dissolved nutrients, water temperature, depth of sunlight penetration.

S.No	Aquatic ecosystem	Characteristics
1.	Fresh Water Ecosystem	Fresh water ecosystem are classified as lotic (moving water) or lentic (still or stagnant water). Lotic water system includes freshwater streams, springs, rivulets, creeks, brooks, and rivers. Lentic water bodies include pools, ponds, some swamps, bogs and lakes. They vary considerably in physical, chemical and biological characteristics.
2.	Marine Ecosystem	Nearly three – quarter of earth's surface is covered by ocean with an average depth of 3,750 m and with salinity 35 ppt, (parts per thousand), about 90 per cent of which is sodium chloride.
3.	Estuaries	Coastal bays, river mouths and tidal marshes form the estuaries. In estuaries, fresh water from rivers meet ocean water and the two are mixed by action of tides. Estuaries are highly productive as compared to the adjacent river or sea.
4.	Coral reef	They occur in shallow tropical areas where the sea water is clean, clear and warm. Coral reefs are one of the most productive and complex coastal ecosystems with high biological diversity.
5.	Mangrove	They are basically evergreen land plants growing on sheltered shores, typically on tidal flats, deltas, estuaries, bays, creeks and the barrier islands. They require high solar radiation and have the ability to absorb fresh water from saline/ brackish water.

1.3.6. Biosphere

Biosphere is a part of the earth where life can exist. Biosphere represents a highly integrated and interacting zone comprising of atmosphere (air), hydrosphere (water) and lithosphere (land).



It is a narrow layer around the surface of the earth. If we visualise the earth to be the size of an apple the biosphere would be as thick as its skin.

Life in the biosphere is abundant between 200 metres (660 feet) below the surface of the ocean and about 6,000 metres (20,000 feet) above sea level.

Biosphere is absent at extremes of the North and South poles, the highest mountains and the deepest oceans, since existing hostile conditions there do not support life. Occasionally spores of fungi and bacteria do occur at great height beyond 8,000 metres, but they are not metabolically active, and hence represent only dormant life.

The energy required for the life within the biosphere comes from the sun. The nutrients necessary for living organisms come from air, water and soil. The same chemicals are recycled over and over again for life to continue.

Living organisms are not uniformly distributed throughout the biosphere. Only a few organisms live in the polar regions, while the tropical rain forests have an exceedingly rich diversity of plants and animals (50% of Global Biodiversity).

CHAPTER - 2

FUNCTIONS OF AN ECOSYSTEM

The function of an ecosystem is a broad, vast and complete dynamic system. It can be studied under the following three heads.

- Energy flow
- Nutrient cycling (biogeochemical cycles)
- Ecological succession or ecosystem development

2.1 ENERGY FLOW

Energy is the basic force responsible for all metabolic activities. The flow of energy from producer to top consumers is called energy flow which is unidirectional.

The study of Trophic level interaction in an ecosystem gives an idea about the energy flow through the ecosystem.

2.1.1. Trophic level interaction

Trophic level interaction deals with how the members of an ecosystem are connected based on nutritional needs.

Trophic levels (Trophe = nourishment)		
I	Autotrophs	Green plants (producers)
II	Heterotrophs	Herbivore (primary consumers)
III	Heterotrophs	Carnivores (secondary consumers)
IV	Heterotrophs	Carnivore (tertiary consumers)
V	Heterotrophs	Top carnivores (Quarternary consumers)

Energy flows through the trophic levels: from producers to subsequent trophic levels. This energy always flows from lower (producer) to higher (herbivore, carnivore etc.) trophic level. It never flows in the reverse direction that is from carnivores to herbivores to producers.

There is a loss of some energy in the form of unusable heat at each trophic level so that energy level decreases from the first trophic level upwards.

As a result there are usually four or five trophic levels and seldom more than six as beyond that very little energy is left to support any organism. Trophic levels are numbered according to the steps an organism is away from the source of food or energy, that is the producer.

The trophic level interaction involves three concepts namely:-

1. Food Chain
2. Food Web
3. Ecological Pyramids

2.2. FOOD CHAIN

Organisms in the ecosystem are related to each other through feeding mechanism or trophic levels, i.e. one organism becomes food for the other. A sequence of organisms that feed on one another, form a food chain. A food chain starts with producers and ends with top carnivores.

The sequence of eaten and being eaten, produces transfer of food energy and it is known as food chain. The plant converts solar energy into chemical energy by photosynthesis.

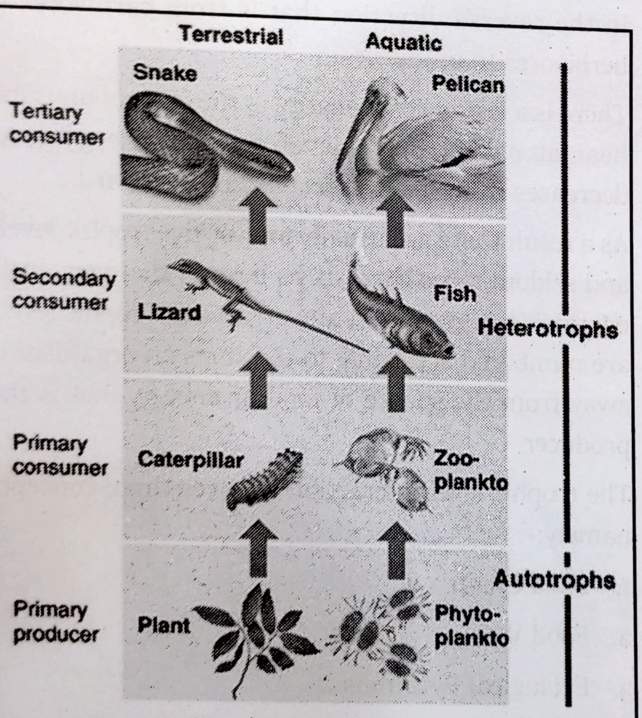
Small herbivores consume the plant matter and convert them into animal matter. These herbivores are eaten by large carnivores.

2.2.1. Types of Food Chains

In nature, two main types of food chains have been distinguished:

i) Grazing food chain

The consumers which start the food chain, utilising the plant or plant part as their food, constitute the grazing food chain. This food chain begins from green plants at the base and the primary consumer is herbivore.



Grazing Food Chain

For example, In terestrial ecosystem, grass is eaten up by caterpillar, which is eaten by lizard and lizard is eaten by snake.

In Aquatic ecosystem phytoplanktons (primary producers) is eaten by zoo planktons which is eaten by fishes and fishes are eaten by pelicans.

ii) Detritus food chain

It starts from dead organic matter of decaying animals and plant bodies consumed by the micro-organisms and then to detritus feeding organism called detrivores or decomposer and to other predators.

Litter → Earthworms → Chicken → Hawk

Detritus food chain

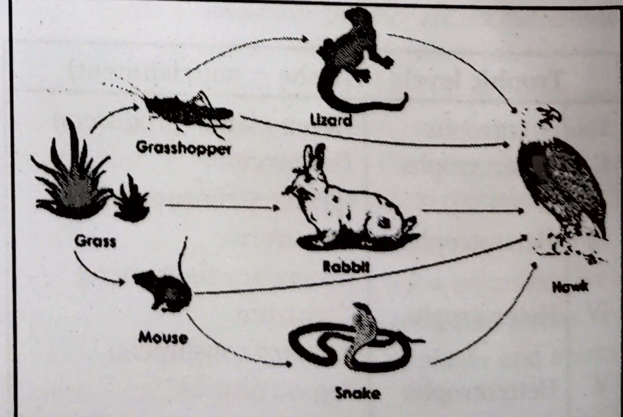
The distinction between these two food chains is the source of energy for the first level consumers. In the grazing food chain the primary source of energy is living plant biomass while in the detritus food chain the source of energy is dead organic matter or detritus. The two food chains are linked. The initial energy source for detritus food chain is the waste materials and dead organic matter from the grazing food chain.

2.3. FOOD WEB

A food chain represents only one part of the food or energy flow through an ecosystem and implies a simple, isolated relationship, which seldom occurs in the ecosystems.

An ecosystem may consist of several interrelated food chains. More typically, the same food resource is part of more than one chain, especially when that resource is at the lower trophic levels.

"A food web illustrates, all possible transfers of energy and nutrients among the organisms in an ecosystem, whereas a food chain traces only one pathway of the food".



A Food Web In a Grassland Ecosystem With Five Possible Food Chains

If any of the intermediate food chain is removed, the succeeding links of the chain will be affected largely. The food web provides more than one alternative for food to most of the organisms in an ecosystem and therefore increases their chance of survival.

For example, grasses may serve food for rabbit or grasshopper or goat or cow. Similarly a herbivore may be food source for many carnivorous species.

Also food availability and preferences of food of the organisms may shift seasonally e.g. we eat watermelon in summer and peaches in the winter. Thus there are interconnected networks of feeding relationships that take the form of food webs.

2.4. ECOLOGICAL PYRAMIDS

The steps of trophic levels expressed in a diagrammatic way are referred as ecological pyramids. The food producer forms the base of the pyramid and the top carnivore forms the tip. Other consumer trophic levels are in between.

The pyramid consists of a number of horizontal bars depicting specific trophic levels which are arranged sequentially from primary producer level through herbivore, carnivore onwards. The length of each bar represents the total number of individuals at each trophic level in an ecosystem.

The number, biomass and energy of organisms gradually decrease with each step from the producer level to the consumer level and the diagrammatic representation assumes a pyramid shape.

The ecological pyramids are of three categories.

1. Pyramid of numbers,
2. Pyramid of biomass, and
3. Pyramid of energy or productivity.

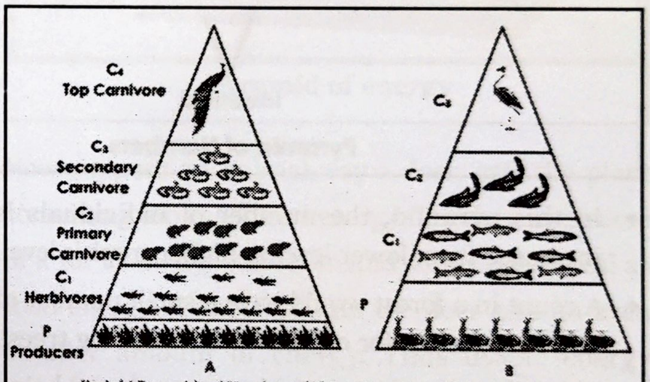
2.4.1. Pyramid of Numbers

This deals with the relationship between the numbers of primary producers and consumers of different levels. It is a graphic representation of the total number of individuals of different species, belonging to each trophic level in an ecosystem.

Depending upon the size and biomass, the pyramid of numbers may not always be upright, and may even be completely inverted.

(a) Pyramid of numbers - upright

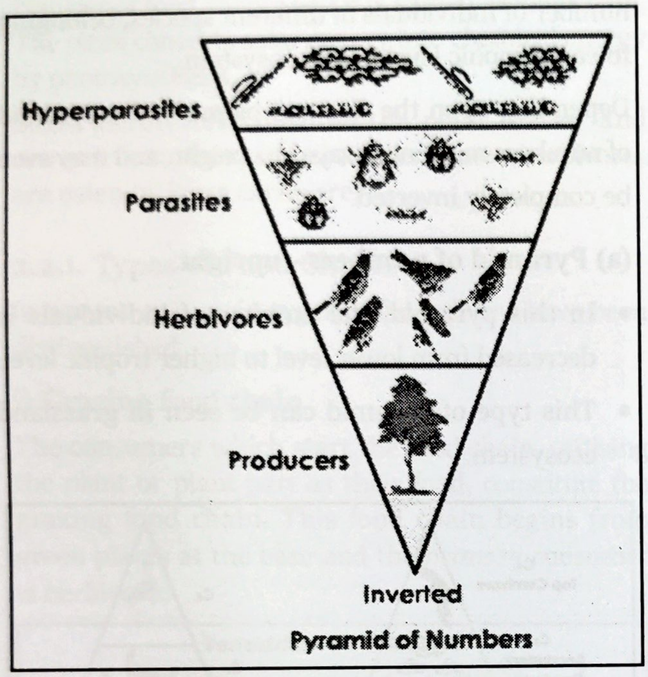
- In this pyramid, the number of individuals is decreased from lower level to higher trophic level.
- This type of pyramid can be seen in grassland ecosystem.



Upright Pyramids of Numbers. (A) In a Grass Land (B) In a Pond

- The grasses occupy the lowest trophic level (base) because of their abundance.
- The next higher trophic level is primary consumer - herbivore (example – grasshopper). The individual number of grasshopper is less than that of grass.
- The next energy level is primary carnivore (example – rat). The number of rats are less than grasshopper, because, they feed on grasshopper. The next higher trophic level is secondary carnivore (example – snakes). They feed on rats.
- The next higher trophic level is the top carnivore. (Ex.Hawk).
- With each higher trophic level, the number of individual decreases.

(b) Pyramid of numbers - inverted



Inverted
Pyramid of Numbers

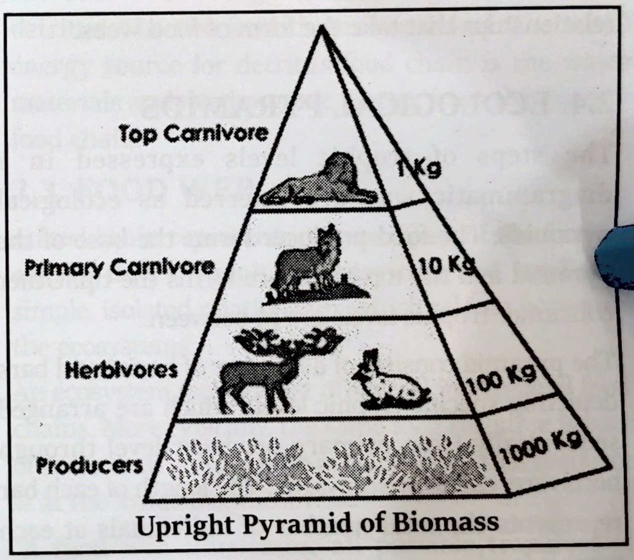
- In this pyramid, the number of individuals is increased from lower level to higher trophic level.
- A count in a forest would have a small number of large producers, for e.g. few number of big trees.
- This is because the tree (primary producer) being few in number and would represent the base of the pyramid and the dependent herbivores (Example - Birds) in the next higher trophic level and it is followed by parasites in the next trophic level. Hyper parasites being at higher trophic level represents higher in number.
- And the resulting pyramid is in inverted shape. A pyramid of numbers does not take into account the fact that the size of organisms being counted in each trophic level can vary.
- It is very difficult to count all the organisms, in a pyramid of numbers and so the pyramid of number does not completely define the trophic structure for an ecosystem.

2.4.2. Pyramid of Biomass

In order to overcome the shortcomings of pyramid of numbers, the pyramid of biomass is used. In this approach individuals in each trophic level are weighed instead of being counted. This gives us a pyramid of biomass, i.e., the total dry weight of all organisms at each trophic level at a particular time.

Pyramid of biomass is usually determined by collecting all organisms occupying each trophic level separately and measuring their dry weight. This overcomes the size difference problem because all kinds of organisms at a trophic level are weighed. Biomass is measured in g/m².

(a) Upward pyramid



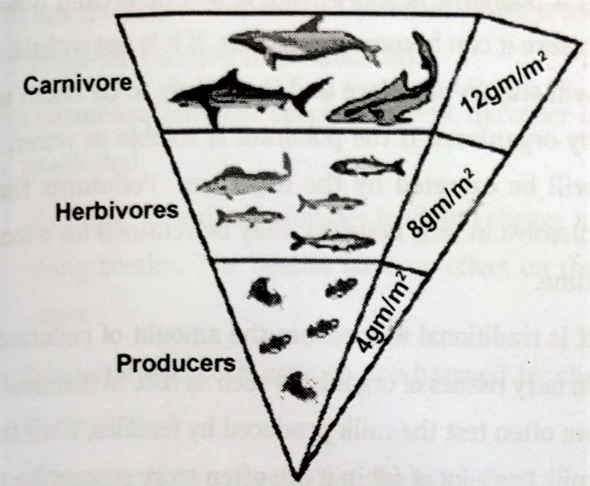
Upright Pyramid of Biomass

For most ecosystems on land, the pyramid of biomass has a large base of primary producers with a smaller trophic level perched on top.

The biomass of producers (autotrophs) is at the maximum. The biomass of next trophic level i.e primary consumers is less than the producers. The biomass of next higher trophic level i.e secondary consumers is less than the primary consumers. The top, high trophic level has very less amount of biomass.

(b) Inverted pyramid

In contrast, in many aquatic ecosystems, the pyramid of biomass may assume an inverted form.



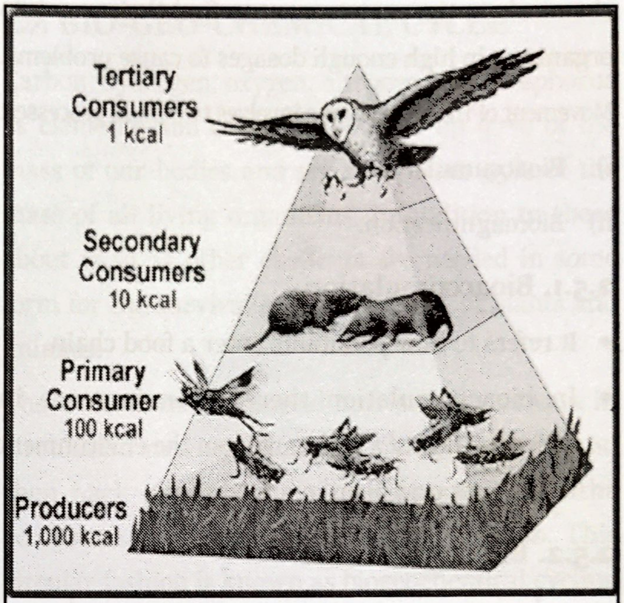
Inverted Pyramid in an Aquatic Ecosystem

This is because the producers are tiny phytoplanktons that grow and reproduce rapidly. Here, the pyramid of biomass has a small base, with the consumer biomass at any instant actually exceeding the producer biomass and the pyramid assumes inverted shape.

2.4.3. Pyramid of Energy

To compare the functional roles of the trophic levels in an ecosystem, an energy pyramid is most suitable. An energy pyramid, reflects the laws of thermodynamics, with conversion of solar energy to chemical energy and heat energy at each trophic level and with loss of energy being depicted at each transfer to another trophic level. Hence the pyramid is always upward, with a large energy base at the bottom.

Let us explain this with an example. Suppose an ecosystem receives 1000 calories of light energy in a given day. Most of the energy is not absorbed; some is reflected back to space; of the energy absorbed only a small portion is utilised by green plants, out of which the plant uses up some for respiration and of the 1000 calories, therefore only 100 calories are stored as energy rich materials.



Pyramid of energy

Now suppose an animal, say a deer, eats the plant containing 100 cal of food energy. The deer uses some of it for its own metabolism and stores only 10 cal as food energy. A lion that eats the deer gets an even smaller amount of energy. Thus usable energy decreases from sunlight to producer to herbivore to carnivore. Therefore, the energy pyramid will always be upright.

Energy pyramid concept helps to explain the phenomenon of biological magnification-the tendency for toxic substances to increase in concentration progressively at higher levels of the food chain.

2.5 POLLUTANTS AND TROPHIC LEVEL

Pollutants especially nondegradable ones move through the various trophic levels in an ecosystem. Nondegradable pollutants mean materials, which cannot be metabolized by the living organisms.

Example: chlorinated hydrocarbons.

We are concerned about these phenomena because, together they enable even small concentrations of chemicals in the environment to find their way into organisms in high enough dosages to cause problems.

Movement of these pollutants involves two main processes:

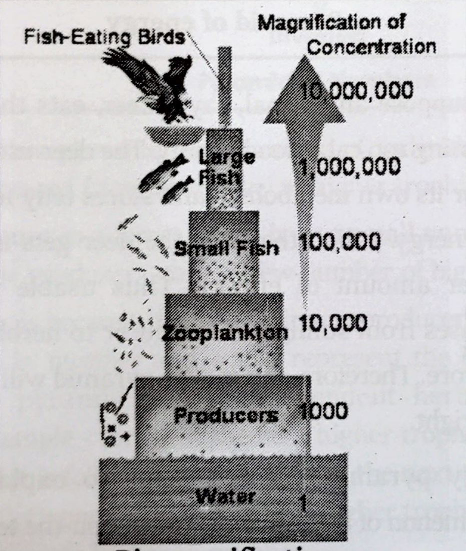
i) Bioaccumulation

ii) Biomagnification.

2.5.1. Bioaccumulation

- It refers to how pollutants enter a food chain.
- In bioaccumulation there is an increase in concentration of a pollutant from the environment to the first organism in a food chain.

2.5.2. Biomagnification



Biomagnification

- Biomagnification refers to the tendency of pollutants to concentrate as they move from one trophic level to the next.
- Thus in biomagnification there is an increase in concentration of a pollutant from one link in a food chain to another.

In order for biomagnification to occur, the pollutant must be: long-lived, mobile, soluble in fats, biologically active.

If a pollutant is short-lived, it will be broken down before it can become dangerous. If it is not mobile, it will stay in one place and is unlikely to be taken up by organisms. If the pollutant is soluble in water, it will be excreted by the organism. Pollutants that dissolve in fats, however, may be retained for a long time.

It is traditional to measure the amount of pollutants in fatty tissues of organisms such as fish. In mammals, we often test the milk produced by females, since the milk has a lot of fat in it are often more susceptible to damage from toxins (poisons). If a pollutant is not active biologically, it may biomagnify, but we really don't worry about it much, since it probably won't cause any problems Examples: DDT.

2.6. BIOTIC INTERACTION

- Organisms living in this earth are interlinked to each other in one way or other. The interaction between the organisms is fundamental for its survival and functioning of ecosystem as a whole.

Biotic Interaction			
S.No.	Type	Spices 1	Species 2
1.	Mutualism	(+)	(+)
2.	Commensalism	(+)	(o)
3.	Amensalism	(–)	(o)
4.	Competition	(–)	(–)
5.	Predation	(+)	(–)
6.	Parasitism	(+)	(–)
(+) Benefited (–) Harmed			
(o) Neither Benefited nor harmed.			

2.6.1. Types of biotic interaction

- **Mutualism:** both species benefit.

  Example: in pollination mutualisms, the pollinator gets food (pollen, nectar), and the plant has its pollen transferred to other flowers for cross-fertilization (reproduction).

- **Commensalism:** one species benefits, the other is unaffected.

  Example: cow dung provides food and shelter to dung beetles. The beetles have no effect on the cows.

- **Competition:** both species are harmed by the interaction.

  Example: if two species eat the same food, and there isn't enough for both, both may have access to less food than they would if alone. They both suffer a shortage of food

- **Predation and parasitism:** one species benefits, the other is harmed.

  Example: predation—one fish kills and eats parasitism: tick gains benefit by sucking blood; host is harmed by losing blood.

- **Amensalism:** One species is harmed, the other is unaffected.

  Example: A large tree shades a small plant, retarding the growth of the small plant. The small plant has no effect on the large tree.

- **Neutralism:** There is no net benefit or harm to either species. Perhaps in some interspecific interactions, the costs and benefits experienced by each partner are exactly the same so that they sum to zero. It is not clear how often this happens in nature. Neutralism is also sometimes described as the relationship between two species inhabiting the same space and using the same resources, but that have no effect on each other. In this case, one could argue that they aren't interacting at all.

2.7. BIO-GEO-CHEMICAL CYCLE

Carbon, hydrogen, oxygen, nitrogen and phosphorus as elements and compounds make up 97% of the mass of our bodies and are more than 95% of the mass of all living organisms. In addition to these about 15 to 25 other elements are needed in some form for the survival and good health of plants and animals.

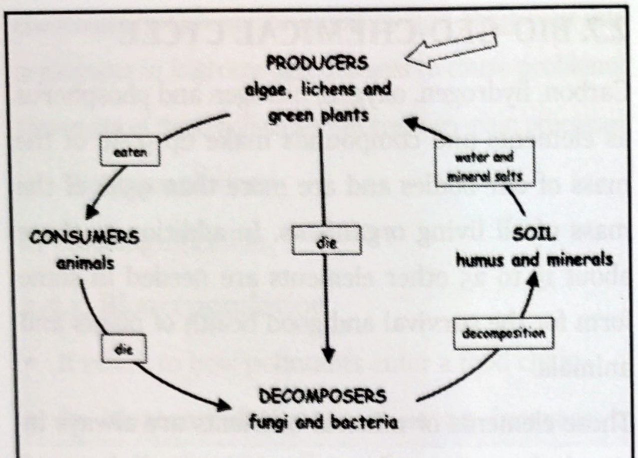
These elements or mineral nutrients are always in circulation moving from non-living to living and then back to the non-living components of the ecosystem in a more or less circular fashion. This circular fashion is known as biogeochemical cycling (bio for living; geo for atmosphere).

2.7.1. Nutrient Cycling

The nutrient cycle is a concept that describes how nutrients move from the physical environment to the living organisms, and subsequently recycled back to the physical environment.

This movement of nutrients from the environment into plants and animals and again back to the environment is essential for life and it is the vital function of the ecology of any region. In any particular environment, to maintain its organism in a sustained manner, the nutrient cycle must be kept balanced and stable.

Nutrient cycling is typically studied in terms of specific nutrients, with each nutrient in an environment having its own particular pattern of cycling. Among the most important nutrient cycles are the carbon nutrient cycle and the nitrogen nutrient cycle. Both of these cycles make up an essential part of the overall soil nutrient cycle. There are many other nutrient cycles that are important in ecology, including a large number of trace mineral nutrient cycles.



Nutrient cycling

Types of Nutrient Cycle

- Based on the replacement period a nutrient cycle is referred to as Perfect or Imperfect cycle.
- A perfect nutrient cycle is one in which nutrients are replaced as fast as they are utilised. Most gaseous cycles are generally considered as perfect cycles.
- In contrast sedimentary cycles are considered relatively imperfect, as some nutrients are lost from the cycle and get locked into sediments and so become unavailable for immediate cycling.
- Based on the nature of the reservoir, there are two types of cycles namely Gaseous and sedimentary cycle
- Gaseous Cycle – where the reservoir is the atmosphere or the hydrosphere, and
- Sedimentary Cycle – where the reservoir is the earth's crust.

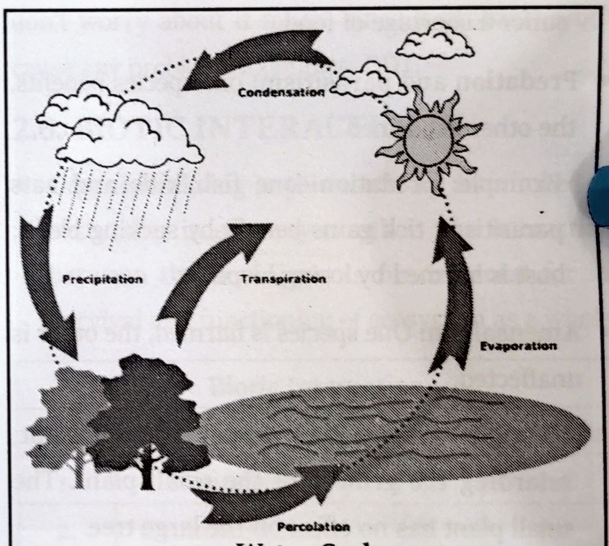
2.7.2. Gaseous Cycles

Let us first study some of the most important gaseous cycles; namely – water, carbon and nitrogen.

(a) Water Cycle (Hydrologic)

Water as an important ecological factor determines the structure and function of the ecosystem. Cycling of all other nutrients is also dependent upon water as it provides their transportation during the various steps. It acts as a solvent medium for their uptake of nutrients by organisms.

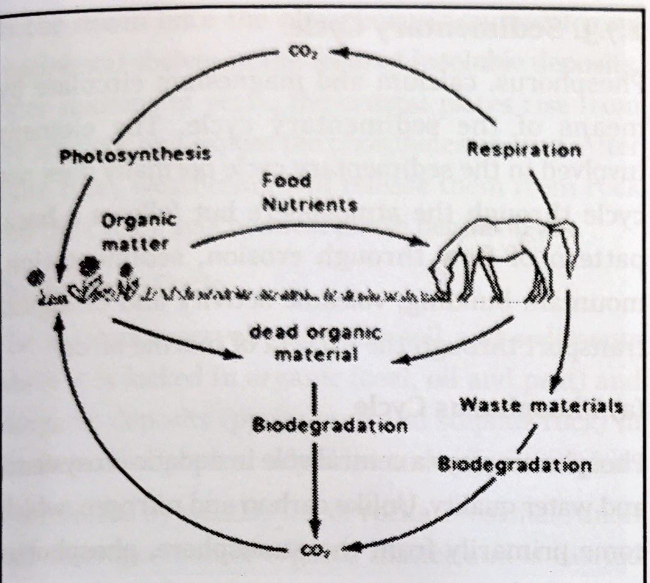
The hydrologic cycle is the continuous circulation of water in the Earth-atmosphere system which is driven by solar energy. Water on our planet is stored in major reservoirs like atmosphere, oceans, lakes, rivers, soils, glaciers, snowfields, and groundwater. Water moves from one reservoir to another by the processes of evaporation, transpiration, condensation, precipitation, deposition, runoff, infiltration, and groundwater flow.



Water Cycle

(b) The Carbon Cycle

Carbon is a minor constituent of the atmosphere as compared to oxygen and nitrogen. However, without carbon dioxide life could not exist, because it is vital for the production of carbohydrates through photosynthesis by plants. It is the element that anchors all organic substances from coal and oil to DNA (deoxyribonucleic acid: the compound that carries genetic information).



Carbon Cycle

Carbon is present in the atmosphere, mainly in the form of carbon dioxide (CO_2). Carbon cycle involves a continuous exchange of carbon between the atmosphere and organisms. Carbon from the atmosphere moves to green plants by the process of photosynthesis, and then to animals. By process of respiration and decomposition of dead organic matter it returns back to atmosphere. It is usually a short term cycle.

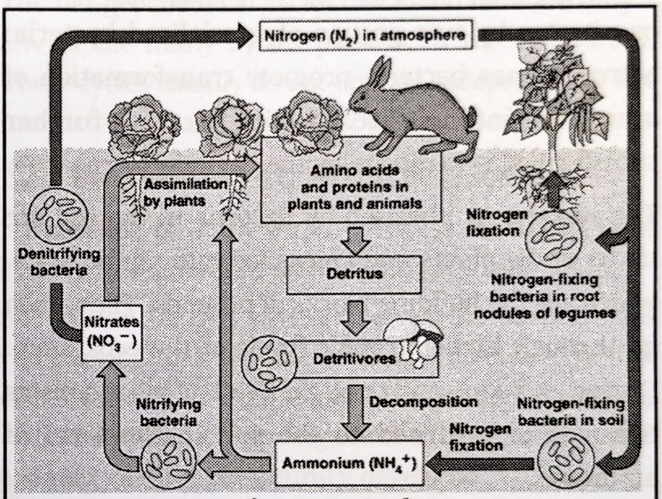
Some carbon also enters a long term cycle. It accumulates as un-decomposed organic matter in the peaty layers of marshy soil or as insoluble carbonates in bottom sediments of aquatic systems which take a long time to be released.

In deep oceans such carbon can remained buried for millions of years till geological movement may lift these rocks above sea level. These rocks may be exposed to erosion, releasing their carbon dioxide, carbonates and bicarbonates into streams and rivers.

Fossil fuels such as coals, oil and natural gas etc. are organic compounds that were buried before they could be decomposed and were subsequently transformed by time and geological processes into fossil fuels. When they are burned the carbon stored in them is released back into the atmosphere as carbon-dioxide.

(c) The Nitrogen Cycle

Nitrogen is an essential constituent of protein and is a basic building block of all living tissue. It constitutes nearly 16% by weight of all the proteins.



Nitrogen Cycle

There is an inexhaustible supply of nitrogen in the atmosphere but the elemental form cannot be used directly by most of the living organisms. Nitrogen needs to be 'fixed', that is, converted to ammonia, nitrites or nitrates, before it can be taken up by plants.

Nitrogen fixation on earth is accomplished in three different ways:

(i) By microorganisms (bacteria and blue-green algae)

(ii) By man using industrial processes (fertilizer factories) and

(iii) To a limited extent by atmospheric phenomenon such as thunder and lighting

Certain microorganisms are capable of fixing atmospheric nitrogen into ammonium ions. These include free living nitrifying bacteria (e.g. aerobic Azotobacter and anaerobic Clostridium) and symbiotic nitrifying bacteria living in association with leguminous plants and symbiotic bacteria living in non leguminous root nodule plants (e.g. Rhizobium) as well as blue green algae (e.g. Anabaena, Spirulina).

Ammonium ions can be directly taken up as a source of nitrogen by some plants, or are oxidized to nitrites or nitrates by two groups of specialised bacteria: Nitrosomonas bacteria promote transformation of ammonia into nitrite. Nitrite is then further transformed into nitrate by the bacteria Nitrobacter.

The nitrates synthesised by bacteria in the soil are taken up by plants and converted into amino acids, which are the building blocks of proteins. These then go through higher trophic levels of the ecosystem. During excretion and upon the death of all organisms nitrogen is returned to the soil in the form of ammonia.

Certain quantity of soil nitrates, being highly soluble in water, is lost to the system by being transported away by surface run-off or ground water. In the soil as well as oceans there are special denitrifying bacteria (e.g. Pseudomonas), which convert the nitrates/nitrites to elemental nitrogen. This nitrogen escapes into the atmosphere, thus completing the cycle.

The periodic thunderstorms convert the gaseous nitrogen in the atmosphere to ammonia and nitrates which eventually reach the earth's surface through precipitation and then into the soil to be utilized by plants.

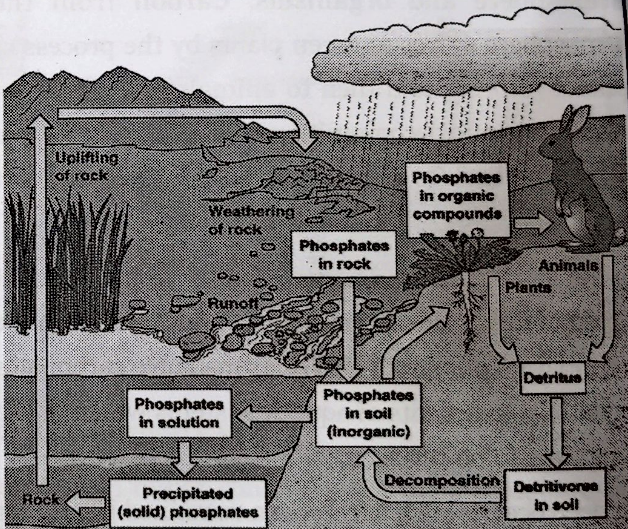
The amount of Nitrogen fixed by man through industrial process has far exceeded the amount fixed by the Natural Cycle. As a result Nitrogen has become a pollutant which can disrupt the balance of nitrogen. It may lead to Acid rain, Eutrophication and Harmful Algal Blooms.

2.7.3. Sedimentary Cycle

Phosphorus, calcium and magnesium circulate by means of the sedimentary cycle. The element involved in the sedimentary cycle normally does not cycle through the atmosphere but follows a basic pattern of flow through erosion, sedimentation, mountain building, volcanic activity and biological transport through the excreta of marine birds.

(a) Phosphorus Cycle

Phosphorus plays a central role in aquatic ecosystems and water quality. Unlike carbon and nitrogen, which come primarily from the atmosphere, phosphorus occurs in large amounts as a mineral in phosphate rocks and enters the cycle from erosion and mining activities. This is the nutrient considered to be the main cause of excessive growth of rooted and free-floating microscopic plants in lakes.



Phosphorous cycle

The main storage for phosphorus is in the earth's crust. On land phosphorus is usually found in the form of phosphates. By the process of weathering and erosion phosphates enter rivers and streams that transport them to the ocean.

In the ocean once the phosphorus accumulates on continental shelves in the form of insoluble deposits. After millions of years, the crustal plates rise from the sea floor and expose the phosphates on land. After more time, weathering will release them from rock and the cycle's geochemical phase begins again.

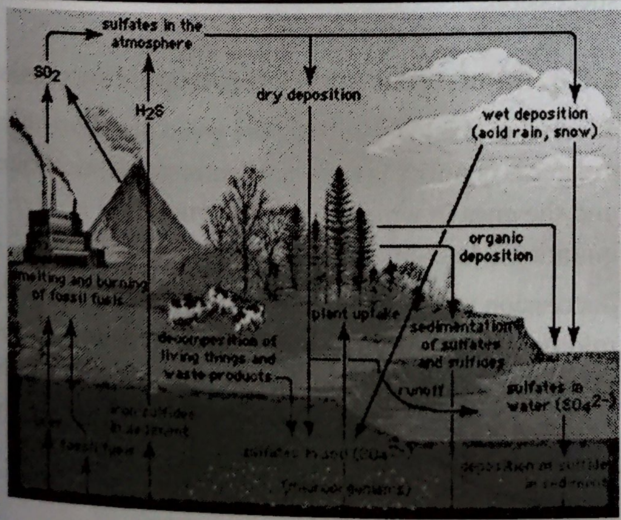
(b) Sulphur Cycle

The sulphur reservoir is in the soil and sediments where it is locked in organic (coal, oil and peat) and inorganic deposits (pyrite rock and sulphur rock) in the form of sulphates, sulphides and organic sulphur.

It is released by weathering of rocks, erosional runoff and decomposition of organic matter and is carried to terrestrial and aquatic ecosystems in salt solution.

The sulphur cycle is mostly sedimentary except two of its compounds hydrogen sulphide (H_2S) and sulphur dioxide (SO_2) add a gaseous component to its normal sedimentary cycle.

Sulphur enters the atmosphere from several sources like volcanic eruptions, combustion of fossil fuels, from surface of ocean and from gases released by decomposition. Atmospheric hydrogen sulphide also gets oxidised into sulphur dioxide. Atmospheric sulphur dioxide is carried back to the earth after being dissolved in rainwater as weak sulphuric acid.


sulfates in the atmosphere
SO2
H2S
dry deposition
wet deposition (acid rain, snow)
organic deposition
smelting and burning of fossil fuels
plant uptake
decomposition of living things and waste products
sedimentation of sulfates and sulfides
runoff
sulfates in water (SO42-)
fossil fuels

Sulphur Cycle

Whatever the source, sulphur in the form of sulphates is take up by plants and incorporated through a series of metabolic processes into sulphur bearing amino acid which is incorporated in the proteins of autotroph tissues. It then passes through the grazing food chain.

Sulphur bound in living organism is carried back to the soil, to the bottom of ponds and lakes and seas through excretion and decomposition of dead organic material.

The Bio-geochemical cycles discussed here are only a few of the many cycles present in the ecosystem. These cycles usually do not operate independently but interact with each other at some point or the other.

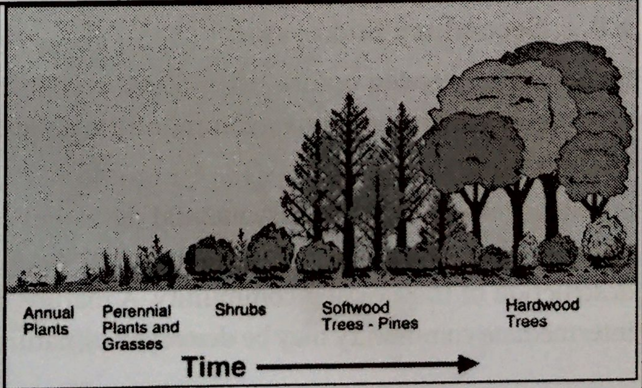
2.8. ECOLOGICAL SUCCESSION

Succession is a universal process of directional change in vegetation, on an ecological time scale.

Succession occurs when a series of communities replace one another due to large scale destruction either natural or manmade. This process continues - one community replacing another community, until a stable, mature community develops.

Succession is characterised by the following: increased productivity, the shift of nutrients from' the reservoirs, increased diversity of organisms with increased niche development, and a gradual increase in the complexity of food webs.

Succession is a progressive series of changes which leads to the establishment of a relatively stable climax community.



Ecological Succession

The first plant to colonise an area is called the pioneer community. The final stage of succession is called the climax community. The stage leading to the climax community are called successional stages or seres.

2.8.1. Primary Succession

In primary succession on a terrestrial site the new site is first colonized by a few hardy pioneer species that are often microbes, lichens and mosses. The pioneers over a few generations alter the habitat conditions by their growth and development.

These new conditions may be conducive to the establishment of additional organisms that may subsequently arrive at the site. The pioneers through their death any decay leave patches of organic matter in which small animals can live.

The organic matter produced by these pioneer species produce organic acids during decomposition that dissolve and etch the substratum releasing nutrients to the substratum. Organic debris accumulates in pockets and crevices, providing soil in which seeds can become lodged and grow.

As the community of organisms continues to develop, it becomes more diverse and competition increases, but at the same time new niche opportunities develops.

The pioneer species disappear as the habitat conditions change and invasion of new species progresses, leading to the replacement of the preceding community.

2.8.2. Secondary Succession

Secondary succession occurs when plants recognize an area in which the climax community has been disturbed.

Secondary succession is the sequential development of biotic communities after the complete or partial destruction of the existing community. A mature or intermediate community may be destroyed by natural events such as floods, droughts, fires, or storms or by human interventions such as deforestation, agriculture, overgrazing, etc

This abandoned farmland is first invaded by hardy species of grasses that can survive in bare, sun-baked soil. These grasses may be soon joined by tall grasses and herbaceous plants. These dominate the ecosystem for some years along with mice, rabbits, insects and seed-eating birds.

Eventually, some trees come up in this area, seeds of which may be brought by wind or animals. And over the years, a forest community develops. Thus an abandoned farmland over a period becomes dominated by trees and is transformed into a forest

The differences between primary and secondary succession, the secondary succession starts on a well developed soil already formed at the site. Thus secondary succession is relatively faster as compared to primary succession which may often require hundreds of years.

2.8.3. Autogenic and Allogenic Succession

When succession is brought about by living inhabitants of that community itself, the process is called autogenic succession, while change brought about by outside forces is known as allogenic succession.

2.8.4. Autotrophic and Heterotrophic succession

Succession in which, initially the green plants are much greater is quantity is known as autotrophic succession; and the ones in which the heterotrophs are greater in quantity is known as heterotrophic succession.

Succession would occur faster in area existing in the middle of the large continent. This is because, here all propagules or seeds of plants belonging to the different seres would reach much faster, establish and ultimately result in climax community.

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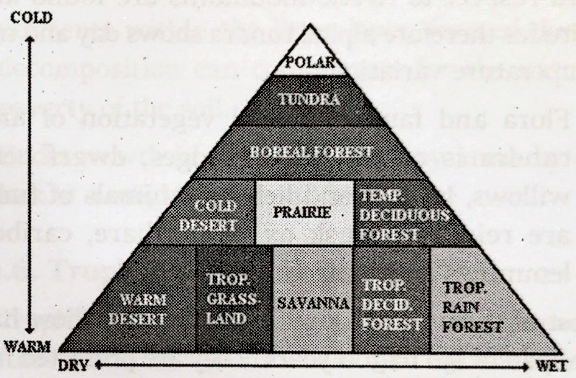
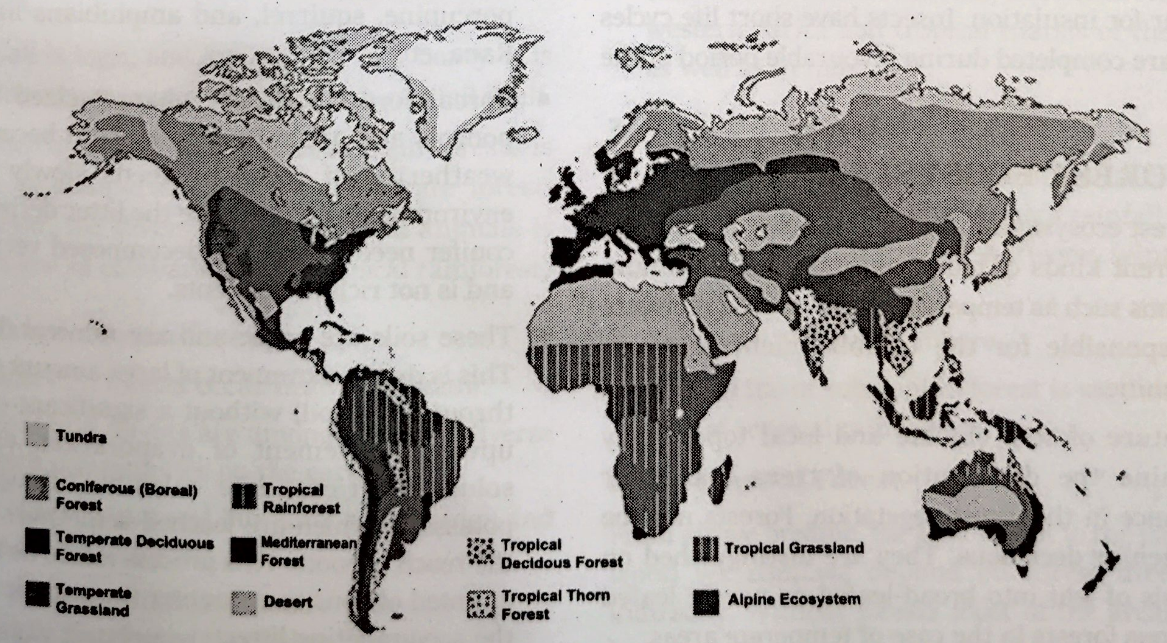
CHAPTER - 3

TERRESTRIAL ECOSYSTEMS

The interrelations between organisms and environment on the land constitute "Terrestrial Ecology". Due to variation in the topographic features of valleys, mountains and slopes, certain differences occur. These differences are reflected in both the material and biotic diversities. Altitudinal and latitudinal variations cause shifts and differences in the climatic patterns. Due to varied climate, the plant and animal life existing in different terrestrial areas vary which result in differentiation of ecosystem as segments within the large biosphere. The most important limiting factors of the terrestrial ecosystems are moisture and temperature. Depending on these factors, terrestrial ecosystems are classified into certain constituent types.



BIOME Distribution based on Temperature and Precipitation



3.1. TUNDRA

Tundra means a "barren land" since they are found where environmental conditions are very severe. There are two types of tundra- arctic and alpine.

- Distribution: Arctic tundra extends as a continuous belt below the polar ice cap and above the tree line in the northern hemisphere. It occupies the northern fringe of Canada, Alaska, European Russia, Siberia and island group of Arctic Ocean. On the south pole, tundra is very small since most of it is covered by ocean .

Alpine tundra occurs at high mountains above the with respect to Arctic mountains are found at all latitudes therefore alpine tundra shows day and night temperature variations.

- Flora and fauna: Typical vegetation of arctic tundra is cotton grass, sedges, dwarf heath, willows, birches and lichens. Animals of tundra are reindeer, musk ox, arctic hare, caribous, lemmings and squirrel.

Most of them have long life e.g. arctic willow has a life span of 150 to 300 years. They are protected from chillness by the presence of thick cuticle and epidermal hair. Mammals of the tundra region have large body size, small tail and small ear to avoid the loss of heat from the surface. The body is covered with fur for insulation. Insects have short life cycles which are completed during favourable period of the year.

3.2. FOREST ECOSYSTEM

The forest ecosystem includes a complex assemblage of different kinds of biotic communities. Optimum conditions such as temperature and ground moisture are responsible for the establishment of forest communities.

The nature of soil, climate and local topography determine the distribution of trees and their abundance in the forest vegetation. Forests may be evergreen or deciduous. They are distinguished on the basis of leaf into broad-leafed or needle leafed coniferous forests in the case of temperate areas.

The forest ecosystems have been classified into three major categories: coniferous forest, temperate forest and tropical forest. All these forest biomes are generally arranged on a gradient from north to south latitude or from high to lower altitude.

Do you know?

Shola forest, Temperate forest is an evergreen ecosystem found at the high altitude regions. It is distributed in Nilgris and Palani hills of Tamil Nadu, Kerala and Karnataka. Sholas are found at sites where adjacent slope converges. These are interrupted by grasslands ecosystem with stunted evergreen woods and confined to sheltered valleys, gleeves, hallows and depressions. The main role of shola forest is conservation of water in that region. It needs well drained soils and avoids swampy soils.

3.2.1. Coniferous forest (boreal forest):

- Cold regions with high rainfall, strong seasonal climates with long winters and short summers are characterised by boreal coniferous forest
- This is characterised by evergreen plant species such as Spruce, fir and pine trees, etc and by animals such as the lynx, wolf, bear, red fox, porcupine, squirrel, and amphibians like Hyla, Rana, etc
- Boreal forest soils are characterized by thin podzols and are rather poor. Both because, the weathering of rocks proceeds slowly in cold environments and because the litter derived from conifer needle (leaf) is decomposed very slowly and is not rich in nutrients.
- These soils are acidic and are mineral deficient. This is due to movement of large amount of water through the soil, without a significant counter-upward movement of evaporation, essential soluble nutrients like calcium, nitrogen and potassium which are leached sometimes beyond the reach of roots. This process leaves no alkaline oriented cations to encounter the organic acids of the accumulating litter.

- The productivity and community stability of a boreal forest are lower than those of any other forest ecosystem.

3.2.2. Temperate deciduous forest:

- The temperate forests are characterised by a moderate climate and broad-leafed deciduous trees, which shed their leaves in fall, are bare over winter and grow new foliage in the spring.
- The precipitation is fairly uniform throughout.
- Soils of temperate forests are podzolic and fairly deep.

3.2.3. Temperate evergreen forest:

- Parts of the world that have Mediterranean type of climate are characterised by warm, dry summers and cool, moist winters.
- These are commonly inhabitated by low broad leafed evergreen trees.
- Fire is an important hazardous factor in this ecosystem and the adaptation of the plants enable them to regenerate quickly after being burnt.

3.2.4. Temperate rain forests:

- The temperate rain forests exhibit a marked seasonality with regard to temperature and rainfall.
- Rainfall is high, and fog may be very heavy. It is the important source of water than rainfall itself.
- The biotic diversity of temperate rain forests is high as compared to other temperate forest. However, the diversity of plants and animals is much low as compared to the tropical rainforest.

3.2.5. Tropical rain forests:

- Tropical rain forests occur near the equator.
- Tropical rain forests are among the most diverse and rich communities on the earth.
- Both temperature and humidity remain high and more or less uniform.
- The annual rainfall exceeds 200 cm and is generally distributed throughout the year.
- The flora is highly diversified
- The extreme dense vegetation of the tropical rain forests remains vertically stratified with tall trees often covered with vines, creepers, lianas, epiphytic orchids and bromeliads.
- The lowest layer is an understory of trees, shrubs, herbs, like ferns and palms.
- Soil of tropical rainforests are red latosols, and they are very thick.
- The high rate of leaching makes these soils virtually useless for agricultural purposes, but when left undisturbed, the rapid cycling of nutrients within the litter layer, formed due to decomposition can compensate for the natural poverty of the soil.
- Undergrowth is restricted in many areas by the lack of sunlight at ground level.

3.2.6. Tropical seasonal forests:

- Tropical seasonal forests also known as monsoon forest occur in regions where total annual rainfall is very high but segregated into pronounced wet and dry periods.
- This kind of forest is found in South East Asia, central and south America, northern Australia, western Africa and tropical islands of the pacific as well as in India.

3.2.7. Subtropical rain forests:

- Broad-leaved evergreen subtropical rain forests are found in regions of fairly high rainfall but less temperature differences between winter and summer
- Epiphytes are common here.
- Animal life of subtropical forest is very similar to that of tropical rainforests.

Importance of Forest

From air we breathe, the food we eat to the paper and wood we use; we depend on forest directly or indirectly. Without forests most of the areas would have been deserts

- Forests keep up the natural balance.
- Forests purify the air
- Forests provide micro climate
- Forests indirectly play a role in precipitation
- Forests prevent floods
- Forests prevent soil erosion
- Forests provide medicinal properties
- Forests provide us fuel and timber
- Forests provide raw materials for industries

3.3. GRASSLAND ECOSYSTEM

The grasslands are found where rainfall is about 25-75 cm per year, not enough to support a forest, but more than that of a true desert.

Typical grasslands are vegetation formations that are generally found in temperate climates.

In India, they are found mainly in the high Himalayas. The rest of India's grasslands are mainly composed of steppes and savannas.

The major difference between steppes and savannas is that all the forage in the steppe is provided only during the brief wet season whereas in the savannas forage is largely from grasses that not only grow during the wet season but also from the smaller amount of regrowth in the dry season.

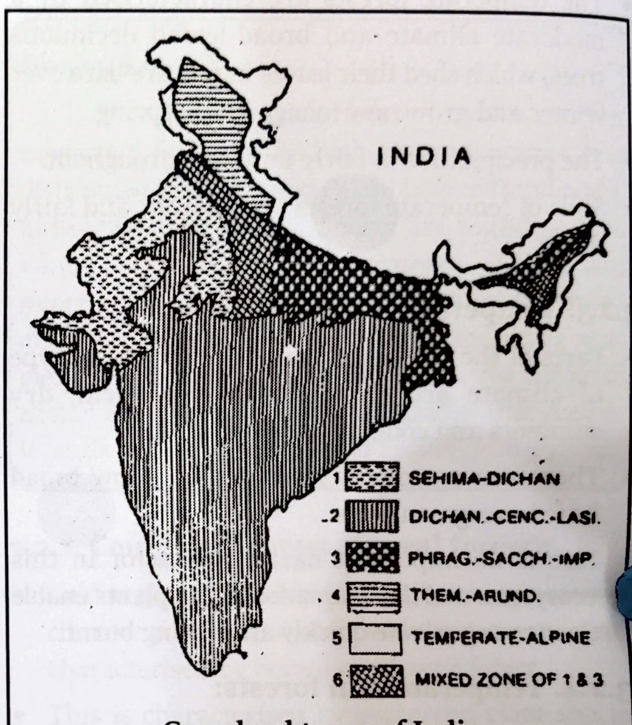
Steppe formations occupy large areas of sandy and saline soil; in western Rajasthan, where the climate is semi-arid, average rainfall is less than 200 mm a year with a dry season of 10 to 11 months, and a large variation in rainfall.

The soil is always exposed, sometimes rocky but more often sandy with fixed or mobile dunes. Forage is available only during the brief wet season. The grass layer is sparse and consists mainly of annual grass species.

In the central and eastern parts of Rajasthan, where the rainfall is about 500 mm per year and the dry season is of six to eight months, dry savanna grazing ecosystems have developed. The light shade cast by the sparse population of trees like khetri favours the growth of the grasses.

3.3.1. Types of Grasslands

Based on climatic conditions there are six types of grasslands found in the different regions of the Indian subcontinent. Four major types of grasslands are discussed here.



Grassland types of India

1) Semi-arid zone

- It covers the northern portion of Gujarat, Rajasthan (excluding Aravallis), western Uttar Pradesh, Delhi and Punjab.
- The topography is broken up by hill spurs and sand dunes.

2) Dry sub humid zone

- It covers the whole of peninsular India (except Nilgiri).

3) Moist sub humid zone

- It covers the Ganga alluvial plain in Northern India.
- The topography is level, low lying and ill-drained.

4) Humid montane regions

- This extends to the humid montane regions and moist sub-humid areas of Assam, Manipur, West

Bengal, Uttar Pradesh, Punjab, Himachal Pradesh and Jammu and Kashmir.

- The savanna is derived from the humid forests on account of shifting cultivation and sheep grazing.

3.3.2. Economic importance of grasslands

- India teems with animals of all shapes and sizes from the buffaloes to sheep's and there are millions of them.
- The livestock wealth plays a crucial role in Indian life. It is a major source of fuel, draught power, nutrition and raw material for village industries.
- But only about 13 million hectares in the country are classified as permanent grazing lands. On top of it, they exist in a highly degraded state.
- Grassland biomes are important to maintain the population of many domesticated and wild herbivores.
- Indian Grasslands and Fodder Research Institute, Jhansi and Central Arid Zone Research institute, Jodhpur.

3.3.3. Impact of grazing

- Due to heavy grazing pressure, the quality of grasslands deteriorates rapidly, the mulch cover of the soil reduces, microclimate becomes more dry and is readily invaded by xerophytic plants and borrowing animals.
- Due to absence of humus cover, mineral soil surface is heavily trampled, when wet it produces puddling of the surface layer. In turn it reduces the infiltration of water into the soil and accelerates run off, resulting in soft erosion.
- These changes contribute to the reduction of energy flow, and the disruption of the stratification and periodicity of the primary producers. It results in a breakdown of the biogeochemical cycles of water, carbon and nitrogen.
- Water and wind erosion completely deteriorates dry grassland microclimate.

3.3.4. Role of fire

- Fire plays an important role in the management of grasslands.
- Under moist conditions fire favours grass over trees, whereas in dry conditions fire is often necessary to maintain grasslands against the invasion of desert shrubs.
- Burning increases the forage yields.

3.4. DESERT ECOSYSTEM

- Deserts are formed in regions with less than 25 cm of annual rainfall, or sometimes in hot regions where there is more rainfall, but unevenly distributed in the annual cycle.
- Lack of rain in the mid latitude is often due to stable high pressure zones; deserts in temperate regions often lie in "rain shadows", that is, where high mountains block off moisture from the seas.
- The climate of these biomes is modified by altitude and latitude. At high altitudes and at greater distance from the equator the deserts are cold and hot near equator and tropics.
- The perennial plant like creosote bush, cactus are scattered throughout the desert biomes.
- In shallow depressed areas with salt deposits geesewood, seepwood and salt grasses are common.
- Because water is the dominant limiting factor, the productivity of a given desert is almost directly dependent on the rainfall. Where soils are suitable, irrigation can convert deserts into productive agricultural land.
- As the large volume of water passes through the irrigation system, salts may be left behind that will gradually accumulate over the years until they become limiting, unless means of avoiding this difficulty are devised.

3.4.1. Adaptations

Desert plants are under hot and dry conditions.

(i) The plants conserve water by following methods:

- They are mostly shrubs.
- Leaves are absent or reduced in size.

- Leaves and stem are succulent and water storing.
- In some plants even the stem contains chlorophyll for photosynthesis.
- Root system is well developed and spread over large area.
- The annuals wherever present germinate, bloom and reproduce only during the short rainy season, and not in summer and winter. This is an adaption to desert condition.

(ii) The animals are physiologically and behaviorally adapted to desert conditions.

- They are fast runners.
- They are nocturnal in habit to avoid the sun's heat during day time.
- They conserve water by excreting concentrated urine.
- Animals and birds usually have long legs to keep the body away from the hot ground.
- Lizards are mostly insectivorous and can live without drinking water for several days.
- Herbivorous animals get sufficient water from the seeds which they eat.
- Camel is known as the ship of the desert as it can travel long distances without drinking water for several days.
- Mammals as a group are poorly adapted to deserts but some species have become secondarily adapted. A few species of nocturnal rodents can live in the desert without drinking water.

3.4.2. Indian Desert – Thar desert (hot)

- The climate of this region is characterised by excessive drought, the rainfall being scanty and irregular.
- The winter rains of northern India rarely penetrate into the region.
- November to March is characterized by extreme variations of temperature and the temperature is frequently below freezing point at night.
- During April to June the heat are intense, frequent scorching winds prevail with great desiccating.
- The relative humidity of the atmosphere is always low.
- The climate is hostile to all vegetation, only plants and animals possessing special adaptations being able to establish themselves.

(a) Flora

The proper desert plants may be divided into two main groups.

i) depending directly upon on rain and

ii) those depending on the presence of subterranean water.

The first group consists of two types:

- depending directly upon on the rain are of two types - the 'ephernerals' and the rain perennials'.
- The ephernerals are delicate annuals, apparently free from any xerophilous adaptations, having slender stems and root-systems and often large flowers. They appear almost immediately after rain, develop flowers and fruits in an incredibly short time, and die as soon as the surface layer of the soil dries up.
- The rain perennials are visible above the ground only during the rainy season, but have a perennial underground stem.
- The second group - depending on the presence of subterranean water
- By far the largest number of indigenous plants are capable of absorbing water from deep below the surface of the ground by means of a well-developed root system, the main part of which generally consists of a slender, woody tap root of extraordinary length.
- Generally, various other xerophilous adaptations are resorted to such as reduced leaves, thick hairy growth, succulence, coatings of wax, thick cuticle, protected stomata, etc., all having for their object of reduction of transpiration.

(b) Fauna

- It is home to some of India's most magnificent grasslands and sanctuary for the Great Indian Bustard.

- Among the mammal, the blackbuck, wild ass, chinkara, caracal, Sandgrouse and desert fox inhabit the open plains, grasslands, and saline depressions.
- The nesting ground of Flamingoes and the only known population of Asiatic wild Ass lies in the remote part of Great Rann, Gujarat.
- It is the migration flyway used by cranes and flamingos.

3.4.3. Cold Desert/ Temperate Desert

Cold desert of India include areas of ladak, leh and kargil of kashmir and spiti valley of Himachal Pradesh and some parts of northern Uttaranchal and Sikkim. These arid areas are not affected by the Indian monsoons because they lie in the rain-shadow of the Himalayan mountain systems.

Characterised by extreme cold weather and denuded terrain they are not suitable for plant growth. Isolated, scattered and over grazed herbaceous shrubs are found. Grazing period is less than 3-4 months.

3.4.4. Characters

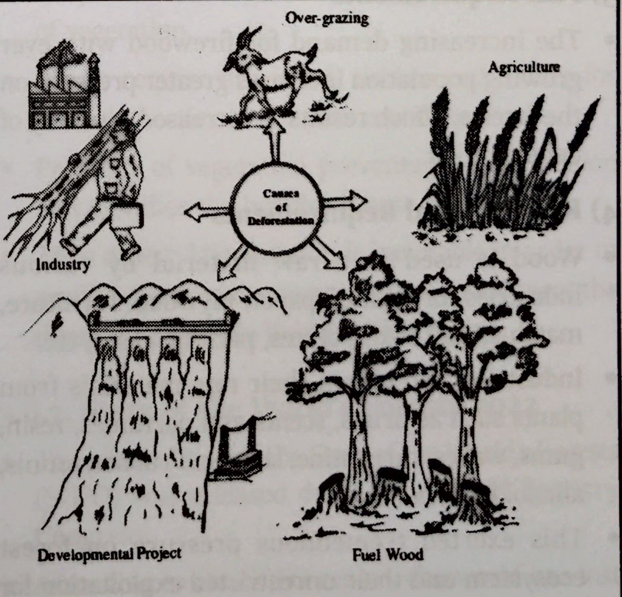
- Severe arid conditions - Dry Atmosphere
- Temperature less than 0°C for most of the period, drops to $-50°C$ during winter.
- insignificant monsoon - Mean annual rainfall less than 400mm
- Heavy snowfall occurs between November and march.
- Soil type - sandy to sandy loam
- Soil pH - neutral to slight alkaline.
- Soil nutrient - Poor organic matter content
- Soil has low water retention capacity.
- Wind erosion is more common.
- Narrow growing period, mostly during the summer.
- Due to aforesaid extreme cold conditions, growth of vegetation is slow and of slunted nature.

Bio-diversity

- Cold desert is the home of highly adaptive, rare endangered fauna, such as Asiatic Ibex, Tibetan Argali, Ladakh Uriyal, Bharal, Tibetan Antelope (chiru), Tibetan Gazelle, Wild Yak, Snow Leopard, Brown Bear, Tibetan Wolf, Wild Dog and Tibetan Wild Ass ('Kiang' a close relative of the Indian wild ass) , Woolly hare, Black Necked Crane, etc.
- Cold desert comprises of alpine mesophytes and desert vegetation.
- Dry temperature zone: Betula, Salix, Juniperus.
- Alphine zone: Junipers, Birch, Rhododendron with grasses.
- Perpetual snow zone: No vegetation due to permanently frozen soil.
- Oak, pine, deodar, birch and rhododendron are the important trees.

3.5. DEFORESTATION

Indiscriminate felling of trees as a result of urbanization, industrialization, mining operations, and use of wood for domestic and other purposes, have caused heavy depletion of forests.



Causes of Deforestation

3.5.1. Causes

1) Shifting cultivation

- In this practice a patch of land is cleared, vegetation is burned and the ash is mixed with the soil thus adding nutrients to the soil.
- This patch of land is used for raising crops for two to three years, and the yield is modest.
- Then this area is abandoned and is left to recover its fertility, and the same practice is repeated elsewhere on a fresh piece of land.
- All that is required for this method of cultivation is a set of simple tools, not high level of mechanisation.

2) Development project

- The human population have increased considerably, so with their requirements.
- Development projects like the hydroelectric projects, large dams and reservoirs, laying down of railway lines and roads are not only extremely beneficial, but they are also linked with several environmental problems.
- Many of these projects require immense deforestation.

3) Fuel Requirements

- The increasing demand for firewood with ever growing population increases greater pressure on the forests, which results in increased intensity of deforestation.

4) Raw Material Requirements

- Wood is used as a raw material by various industries for making paper, plywood, furniture, match sticks, boxes, crates, packing cases, etc.
- Industries also obtain their raw materials from plants such as drugs, scents and perfumes, resin, gums, waxes, turpentine, latex and rubber, tannis, alkaloids, bees wax.
- This exerted tremendous pressure on forest ecosystem and their unrestricted exploitation for various other raw materials is the main cause of degradation of the forest ecosystem.

5) Other Causes

- Deforestation also results from overgrazing, agriculture, mining, urbanization, flood, fire, pest, diseases, defence and communication activites.

3.5.2. How it affects?

- Closed forests (based on canopy level) have being diminished due to deforestation leading to increase in degraded forests.
- Forests recycle moisture from soil into their immediate atmosphere by transpiration where it again precipitates as rain.
- Deforestation results in an immediate lowering of ground water level and in long-term reduction of precipitation.
- Due to deforestation, this natural reuse cycle is broken and water is lost through rapid run off.
- Much of the mining activity in India is being carried out in forest regions. The obvious result is deforestation and soil erosion.
- Underground mining has also significantly denuded forests, as timber is used for supporting the roofs of mine galleries.
- A large number of abandoned mines are lying in bad shape and are under extensive gully erosion leading to degradation of the habitat.
- Deforestation affects the biota and neighbouring ecosystems, soil erosion, land degradation, alteration of ground water channels, pollution and scarce.

3.6. DESERTIFICATION

It is the destruction of biological potential of the land which can ultimately lead to desert like conditions. In arid and semiarid regions, the restoration of the fragile ecosystem is very slow, and issues like deforestation, mining enhances the desertification. Desertification is a main problem faced by desert adjoining areas, which stretches across parts of Rajasthan, Gujarat, Punjab and Haryana.

The cause of this process is not climatic changes, droughts, etc. but human actions.

Causes

- Population pressure
- Increase in cattle population, over grazing
- Increased agriculture
- Development activities
- Deforestation

3.6.1. Status of Indian desertification

"Desertification and Land Degradation Atlas of India"

Published by Space Application Centre, ISRO, Ahmedabad. The Atlas provides state wise area of degraded lands for the time frame 2018-19. It also provides the change analysis for the duration of 15 years, from 2003-05 to 2018-19.

As per the Desertification and Land Degradation Atlas of India, 2021, the percentage of country under dry lands is 68%. The total area undergoing the process of land degradation in India is 97.58 million hectares, which constitutes 29.07 percentage of India's total land area.

82.64 million hectares area of the country is under desertification (land degradation within drylands).

Land restoration is the best solution for biodiversity loss and therefore there is an urgent need to restore the degraded lands. "India has committed to restore 26 million hectares of degraded land by 2030, more than its earlier target of 21 million hectares.

India hosted the 14th session of Conference of Parties (COP 14) of United Nations Convention to Combat Desertification (UNCCD) in September 2019.

India is striving towards achieving the national commitments of Land Degradation Neutrality (LDN) and restoration of 26 Million ha of degraded land by 2030 which focus on sustainable and optimum utilisation of land resources.

Control measures

India is a signatory to United Nations Convention to Combat Desertification (UNCCD). The National Action Programme for combating desertification was prepared in 2001 to take appropriate action in addressing the problems of desertification.

Some of the major programmes currently implemented that address issues related to land degradation and desertification are

- Integrated Watershed Management Programme
- National Afforestation Programme
- National Mission for Green India
- The Mahatma Gandhi National Rural Employment Guarantee Scheme
- Soil Conservation in the Catchment of River Valley Project and Flood Prone River
- National Watershed Development Project for Rainfed Areas
- Desert Development Programme
- Fodder and Feed Development Scheme-component of Grassland Development including Grass Reserves, Command Area Development and Water Management programme etc.

3.6.2. Afforestation

- The desert regions of Rajasthan, Gujarat, Haryana, Punjab and Trans-Himalayan regions are in scarce of vegetation.
- People require fire wood, timber and fodder for their domestic consumptions and livestock.
- Presence of vegetation prevents the soil erosion and modifies the hostile climate.
- Thus desert Afforestation is inevitable in order to modify the climate, desertification and to meet the demands of people living in that region.

3.6.3. State of the World's Forests 2022

- The 2022 edition of the State of the World's Forests (SOFO) was released during the World Forestry Congress.
- According to the SOFO report, the world has lost 420 million hectares of forests in the last 30 years (1990-2020) due to deforestation. This loss is

approximately 10.34% of its total forest area 4.06 billion hectares (31 per cent) of the earth's geographical area.

- It added that although the rate of deforestation was declining, 10 million hectares of forests were lost every year between 2015 and 2020. More than 700 million hectares of forest (18% of total forest area) is in legally established protected areas but forest biodiversity remains under threat from deforestation and forest degradation.
- Unless additional action is taken, an estimated 289 million hectares of forests would be deforested between 2016 and 2050 in the tropics alone
- **Diseases** - SOFO 2022, stated that 15% of 250 emerging infectious diseases have been linked to forests. It further stated that 30% of new diseases, reported since 1960, can be attributed to deforestation and land-use-change. Deforestation, particularly in the tropics, has been associated with an increase in infectious diseases such as dengue fever and malaria.
- **Fuel** - Approximately 124 million more people fell into extreme poverty after COVID-19. This may have longer-term impacts on wood-based fuel, as there is evidence of increased wood-based fuel use in some countries during the pandemic.
- **Population** - SOFO 2022 further stated that the world population is projected to reach 9.7 billion people by 2050. This will increase competition for land, as the demand for food for this large population will rise by 35 to 56 per cent by the 2050s. The annual global consumption of all-natural resources combined is expected to more than double from 92 billion tonnes (2017) to 190 billion tonnes (2060) due to increases in population size and affluence.
- It states that according to estimates, restoration of degraded land through afforestation and reforestation could cost-effectively take 0.9 to 1.5 GtCO2e per year out of the atmosphere between 2020 and 2050.
- More than 140 countries have pledged, through the Glasgow Leaders' Declaration on Forests and Land Use, to eliminate forest loss by 2030 and to support restoration and sustainable forestry. To this end, an additional $19 billion has been allocated to help developing countries achieve these objectives.

CHAPTER - 4

AQUATIC ECOSYSTEM

Ecosystems consisting of water as the main habitat are known as aquatic ecosystems. Aquatic ecosystems are classified based on their salt content.

i) **Fresh water ecosystems**- The salt content of fresh bodies is very low, always less than 5 ppt (parts per thousand). E.g lakes, ponds, pools, springs, streams, and rivers

ii) **Marine ecosystems** - the water bodies containing salt concentration equal to or above that of sea water (i.e., 35 ppt or above). E.g shallow seas and open ocean

iii) **Brackish water ecosystems** – these water bodies have salt content in between 5 to 35 ppt. e.g. estuaries, salt marshes, mangrove swamps and forests.

4.1. AQUATIC ORGANISMS

The aquatic organisms are classified on the basis of their zone of occurrence and their ability to cross these zones.

The organisms (both flora and fauna) in the aquatic ecosystem are unevenly distributed but can be classified on the basis of their life form or location into five groups

i) Neuston:

- These are unattached organisms which live at the air-water interface such as floating plants, etc.
- Some organisms spend most of their lives on top of the air-water interface such as water striders, while others spend most of their time just beneath the air-water interface and obtain most of their food within the water.
  - E.g., beetles and back-swimmers.

ii) Periphyton:

- These are organisms which remain attached to stems and leaves of rooted plants or substances emerging above the bottom mud such as sessile algae and their associated group of animals.

iii) Plankton:

- This group includes both microscopic plants like algae (phytoplankton) and animals like crustaceans and protozoans (zooplankton) found in all aquatic ecosystems, except certain swift moving waters.
- The locomotory power of the planktons is limited so that their distribution is controlled, largely, by currents in the aquatic ecosystems.

iv) Nekton:

- This group contains animals which are swimmers.
- The nektons are relatively large and powerful as they have to overcome the water currents.
- The animals range in size from the swimming insects (about 2 mm long) to the largest animals, the blue whale.

v) Benthos:

- The benthic organisms are those found living in the bottom of the water mass.
- Practically every aquatic ecosystem contains well developed benthos.

4.1.1. Factors Limiting the Productivity of Aquatic Habitats

> Sunlight and oxygen are most important limiting factors of the aquatic ecosystems whereas moisture and temperature are the main limiting factors of terrestrial ecosystem.

Sunlight:

- Sunlight penetration rapidly diminishes as it passes down the column of water. The depth to which light penetrates a lake determines the extent of plant distribution.
- Based on light penetration and plant distribution they are classified as photic and aphotic zones

Photic zone:

- It is the upper layer of the aquatic ecosystems, up to which light penetrates and within which photosynthetic activity is confined.
- The depth of this zone depends on the transparency of water.
- Both photosynthesis and respiration activity takes place.
- photic (or "euphotic") zone is the lighted and usually well-mixed portion that extends from the lake surface down to where the light level is 1% of that at the surface.

Aphotic zone:

- The lower layers of the aquatic ecosystems, where light penetration and plant growth are restricted forms the aphotic zone.
- Only respiration activity takes place.
- aphotic zone is positioned below the littoral and photic zones to bottom of the lake where light levels are too low for photosynthesis. Respiration occurs at all depths so the aphotic zone is a region of oxygen consumption. This deep, unlit region is also known as the profundal zone.

> **Winter kill**
>
> Snow cover of ice on water body can effectively cut off light, plunging the waters into darkness. Hence photosynthesis stops but respiration continues. Thus in shallow lakes, the oxygen get depleted. Fish die, but we won't know it until the ice melts and we find floating fish. This condition is known as winter kill.

Dissolved oxygen:

- In aquatic ecosystems oxygen is dissolved in water, where its concentration varies constantly depending on factors that influence the input and output of oxygen in water.
- In fresh water the average concentration of dissolved oxygen is 0.0010 per cent (also expressed as 10 parts per million or 10 ppm) by weight, which is 150 times lower than the concentration of oxygen in an equivalent volume of air.
- Oxygen enters the aquatic ecosystem through the air water interface and by the photosynthetic activities of aquatic plants.
- Therefore, the quantity of dissolved oxygen present in an ecosystem depends on the rate at which the aforesaid two processes occur.
- Dissolved oxygen escapes the water body through air-water interface and through respiration of organisms (fish, decomposers, zoo planktons, etc).
- The amount of dissolved oxygen retained in water is also influenced by temperature. Oxygen is less soluble in warm water. Warm water also enhances decomposer activity. Therefore, increasing the temperature of a water body increases the rate at which oxygen is depleted from water.
- When the dissolved oxygen level falls below 3-5 ppm, many aquatic organisms are likely to die.

Other limiting factors which influence on aquatic productivity are

Transparency:

- Transparency affects the extent of light penetration.
- Suspended particulate matters such as clay, silt, phytoplankton, etc make the water turbid.
- Consequently it limits the extent of light penetration and the photosynthetic activity in a significant way.

Temperature:

- The water temperature changes less rapidly than the temperature of air because water has a considerably higher specific heat than air, i.e. larger amounts of heat energy must be added to or taken away from water to raise or lower its temperature.
- Since water temperatures are less subject to change, the aquatic organisms have narrow temperature tolerance limit.
- As a result, even small changes in water temperature are a great threat to the survival of aquatic organisms when compared to the changes in air temperatures in the terrestrial organisms.

The classification of organisms and limiting factors discussed here apply in general to all aquatic ecosystems - lakes,Ponds, Rivers, Streams, Estuaries, oceans and seas.

4.2. LAKE ECOLOGY

Any - body of standing water, generally large enough in area and depth, irrespective of its hydrology , ecology, and other characteristics is generally known as lake.

4.2.1. Ageing of Lakes

- Like any organism, lakes are born as they originate by various geological and geomorphic events, and 'grow' with time to change in their various morphological and functional characteristics and eventually die.
- They receive their water from surface runoff (sometimes also groundwater discharge) and along with it various chemical substances and mineral matter eroded from the land.
- Over periods spanning millennia, 'ageing' occurs as the lakes accumulate mineral and organic matter and gradually, get filled up.

Classification of Lakes

- Lakes are also classified on the basis of their water chemistry. Based on the levels of salinity, they are known as Freshwater, Brackish or Saline lakes (similar to that of classification of aquatic ecosystem).
- On the basis of their nutrient content, they are categorized as Oligotrophic (very low nutrients), Mesotrophic (moderate nutrients) and Eutrophic (highly nutrient rich).

The nutrient-enrichment of the lakes promotes the growth of algae, aquatic plants and various fauna. This process is known as natural eutrophication.

Similar nutrient enrichment of lakes at an accelerated rate is caused by human activities (discharge of wastewaters or agricultural runoff) and the consequent ageing phenomenon is known as 'cultural eutrophication'.

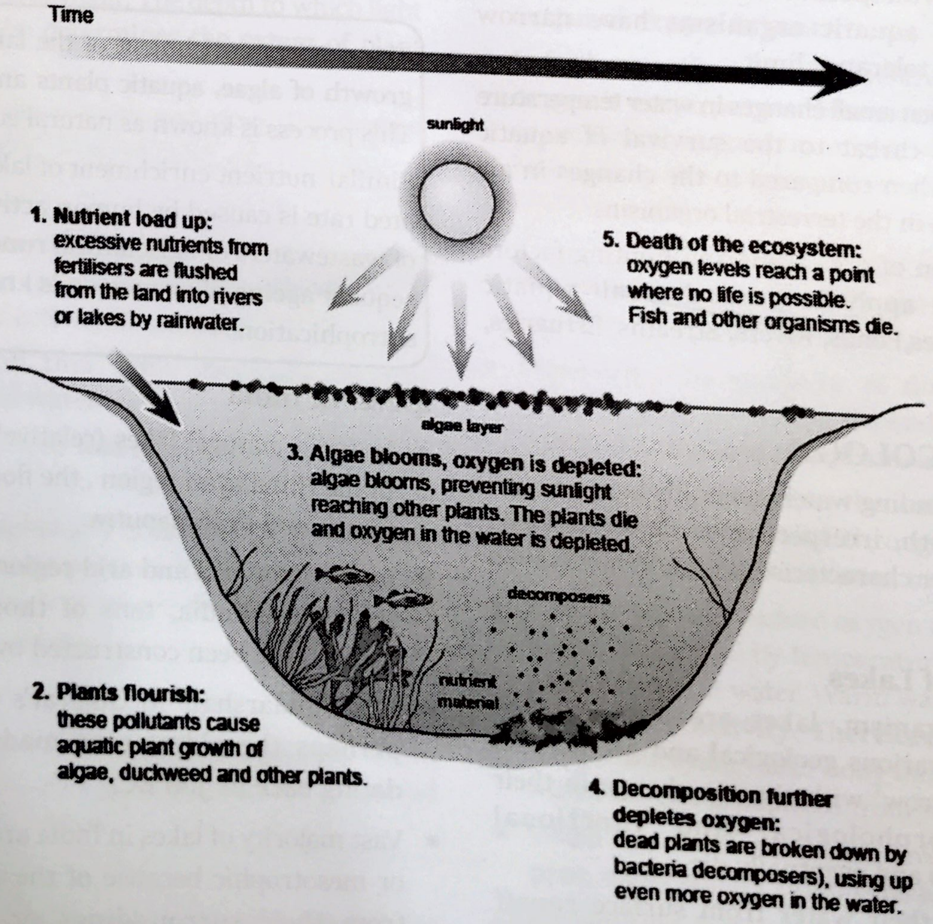
4.2.2. In India

- In India, natural lakes (relatively few) mostly lie in the Himalayan region , the floodplains of Indus, Ganga and Brahmaputra.
- In the semi-arid and arid regions of western and peninsular India, tens of thousands of water bodies have been constructed over millennia.
- Lake 'Sudarshan' in Gujarat's Girnar area was perhaps the oldest man-made lake in India, dating back to 300 BC.
- Vast majority of lakes in India are either eutrophic or mesotrophic because of the nutrients derived from their surroundings or organic wastes entering them.

4.2.3. General Characteristics of Oligotrophic and eutrophic Lakes

Sl. no	Parameter	Type of lake	
		Oligotrophic	Eutrophic
1.	Aquatic plant production	Low	Eliminated due to Eutrophication
2.	Aquatic animal production	Low	Eliminated due to Eutrophication
3.	Aquatic plant nutrient flux	Low	High
4.	Oxygen in the hypolimnion (bottom layer)	Present	Absent
5.	Depth	Tend to be deeper	Tend to be shallower
6.	Water quality for domestic & industrial uses	Good	Poor
7.	Total salts or conductance	Usually lower	Sometimes higher
8.	Number of plant and animal species	Many	Fewer

4.3. EUTROPHICATION


Time
sunlight
1. Nutrient load up: excessive nutrients from fertilisers are flushed from the land into rivers or lakes by rainwater.
5. Death of the ecosystem: oxygen levels reach a point where no life is possible. Fish and other organisms die.
algae layer
3. Algae blooms, oxygen is depleted: algae blooms, preventing sunlight reaching other plants. The plants die and oxygen in the water is depleted.
decomposers
nutrient material
2. Plants flourish: these pollutants cause aquatic plant growth of algae, duckweed and other plants.
4. Decomposition further depletes oxygen: dead plants are broken down by bacteria decomposers), using up even more oxygen in the water.

Process of Eutrophication

- Greek word – Eutrophia means adequate & healthy nutrition.
- Eutrophication is a syndrome of ecosystem, response to the addition of artificial or natural nutrients such as nitrates and phosphates through fertilizer, sewage, etc that fertilize the aquatic ecosystem.
- It is primarily caused by the leaching of phosphate and - or nitrate containing fertilisers from agricultural lands into lakes or rivers.
- The growth of green algae which we see in the lake surface layer is the physical identification of an Eutrophication.
- Some algae and blue-green bacteria thrive on the excess ions and a population explosion covers almost entire surface layer is known as algal bloom. This growth is unsustainable, however.
- As Algal Bloom covers the surface layer, it restricts the penetration of sunlight. Diffusion of gas from atom
- Oxygen is required by all respiring animals in the water and it is replenished by diffusion and photosynthesis of green plants.
- The oxygen level is already low because of the population explosion and further oxygen is taken up by microorganisms which feed off the dead algae during decomposition process.
- Due to reduced oxygen level, fishes and other aquatic organism suffocate and they die.
- The anaerobic conditions can promote growth of bacteria which produces toxins deadly to aquatic organisms, birds and mammals.
- All this eventually leads to degradation of aquatic ecosystem and death of its organisms.
- It often leads to change in animal and plant population & degradation of water & habitat quality.

4.3.1. Types

1. Natural

- Deposition of nutrients [such as depositional environments. When the nutrients flow into the system on temporal basics.
- It Occurs over centuries
- Eg. Seasonally inundated tropical flood plains

2. Manmade

- Occurs in decades
- These inputs may come from untreated sewage discharges, runoff of fertilizer from farm fields, golf courses, park , etc. & from animal wastes, combustion of fossil fuel [produces gases – nitrogen oxides, growing urban population in the coastal areas.

DEGRADATION PROCESS

Agricultural runoff, untreated sewage, etc

↓

Transportation to the aquatic ecosystem

↓

Nutrient accumulation and enrichment

↓

Overgrowth of Algae

↓

Algal Bloom

↓

Algae covering the aquatic surface layer

↓

Restricts the sunlight penetration, Diffusion of D.O.

↓

Underground aquatic Algae, plant's die

↓

Bacterial Decomposition consumes the available oxygen in the aquatic ecosystem

↓

Anoxia condition (Devoid of oxygen)

↓

All aquatic organism die due to lack of D.O

↓

Degradation of aquatic ecosystem

4.3.2. Effects

Change in ecosystem:

- Eutrophication eventually create detritus layer in the ponds & lakes and produces successively shallower depth of surface water.

- Eventually the water body is reduced into marsh whose plant community is transformed from an aquatic environment to recognizable terrestrial ecosystem.

Decreased biodiversity

- Algal blooms restrict the sunlight to penetrate & affects the photosynthesizing plants. It causes death of plants.
- Bacteria consumes all the oxygen on decomposition & results in devoid of oxygen. Eventually it leads to death of all living organism in aquatic ecosystem.

New species invasion

- Eutrophication may cause the ecosystem competitive by transforming the normal limiting nutrient to abundant level. This cause shifting in species composition of ecosystem

Toxicity

- Some algal blooms when die or eaten, release neuro & hepatotoxins which can kill aquatic organism & pose threat to humans. (e.g) Shellfish poisoning.
- Depletion of dissolved oxygen level.
- Increased incidences of fish kills & loss of desirable fish species & reduction in harvesting
- Loss of coral reefs.
- Decrease in water transparency and increased turbidity.
- Affects navigation due to increased turbidity.
- Colour (yellow, green, red), smell and water treatment problems.
- Increased biomass of inedible toxic phytoplankton
- Increase in bloom of gelatinous zooplankton
- Increased biomass of benthic and epiphytic algae
- Unsuitable for aesthetic recreation, and reduction in value of water body

4.3.3. Mitigation

- Riparian buffer
- Interfaces between a flowing body of water and land created near the waterways, farms, roads, etc. in an attempt to filter pollution.
- Sediments and nutrients are deposited in the buffer zones instead of deposition in water.
- Minimizing the non-point pollution.
- Nitrogen testing & modeling
- N-Testing is a technique to find the optimum amount of fertilizer required for crop plants. It will reduce the amount of nitrogen lost to the surrounding area.
- Treatment of Industrial effluents
- Organic farming & Integrated Farming System.
- Reduction in livestock densities
- Improving the efficiency of use of fertilizer
- Treatment of runoff from street & storm drains
- Reduction in nitrogen emission from vehicles and power plants
- Increase in efficiency of nitrogen & phosphorous removal from municipal waste water

4.3.4. Removal of the nutrients from a lake

- Flushing with nutrient-poor waters.
- Deep water abstraction.
- On-site P-elimination by flocculation/flotation with water backflow, or floating Plant NESSIE with adsorbents.
- On-site algae removal by filters and P-adsorbers.
- On-site algae skimming and separator thickening.
- Artificial mixing / Destratification (permanent or intermittent).
- Harvest of fishes and macrophytes.
- Sludge removal.

4.3.5. Policies

- Multi dimensional in Nature should include
- Education & awareness
- Research, monitoring & evaluation
- Regulations.
- Fiscal & economic incentives
- Ecosystem preservation & restoration

4.4. HARMFUL ALGAL BLOOMS

- Algae or phytoplankton are microscopic organisms that can be found naturally in coastal waters. They are major producers of oxygen and food for many of the animals that live in these waters.
- When environmental conditions are favorable for their development, these cells may multiply rapidly and form high numbers of cells and this is called an algal bloom.
- A bloom often results in a color change in the water. Algal blooms can be any color, but the most common ones are red or brown. These blooms are commonly referred to as red or brown tides.
- Most algal blooms are not harmful but some produce toxins and do affect fish, birds, marine mammals and humans. The toxins may also make the surrounding air difficult to breathe. These are known as Harmful Algal Blooms (HABs).

4.4.1. What are the causes of these blooms?

- Blooms occur when several colonies start combining rapidly when conditions such as nutrient concentrations, salinity and temperature are optimal.
- Blooms can be due to a number of reasons. Two common causes are nutrient enrichment and warm waters.
- Nutrient enrichment of water, especially phosphates and nitrogen, is often the result of pollution and can cause algal blooms.
- Water temperature has also been related to the occurrence of algal blooms, with unusually warm water being conducive to blooms.

4.4.2. How are HABs dangerous to fish and humans?

- HABs can deplete oxygen in water and lead to low dissolved oxygen levels.
- **How it depletes oxygen?** When masses of algae die and decompose, the decaying process can deplete oxygen in the water, causing the water to become so low in oxygen.
- When oxygen levels become too low, fish suffocate and die.
- Some algae species in blooms produce potent neurotoxins that can be transferred through the food web where they affect and even kill the higher forms of life such as zooplankton, shellfish, fish, birds, marine mammals, and even humans that feed either directly or indirectly on them.

4.4.3. Why Red Tide is a misnomer?

- “Red Tide” is a common name for such a phenomenon where certain phytoplankton species contain pigments and “bloom” such that the human eye perceives the water to be discolored.
- Blooms can appear greenish, brown, and even reddish orange depending upon the type of organism, the type of water, and the concentration of the organisms.
- The term “red tide” is thus a misnomer because blooms are not always red, they are not associated with tides, they are usually not harmful, and some species can be harmful or dangerous at low cell concentrations that do not discolor the water.
- They are scientifically referred as Harmful Algal Blooms (HABs).

4.4.4. Is HAB’s an environmental hazard?

- Yes, it is because these events can make people sick when contaminated shellfish are eaten, or when people breathe aerosolized HAB toxins near the beach.
- In addition, HAB events can result in the closure of shellfish beds, massive fish kills, death of marine mammals and seabirds, and alteration of marine habitats.
- As a consequence, HAB events adversely affect commercial and recreational fishing, tourism, and valued habitats, creating a significant impact on local economies and the livelihood of coastal residents.

4.4.5. How do we get exposed to HAB toxins?

- Most illness associated with HAB exposure is the result of consuming toxins that are present in shellfish or finfish.

- Some HAB toxins can become airborne during a bloom and people can become ill by inhaling toxins.

4.4.6. Is it safe to eat seafood?

- In general, it is safe to eat seafood.
- However, consuming shellfish that have been harvested from waters with high levels of harmful algae and consuming fish that have lesions or that were caught in an area during an algal bloom can result in illness.

4.4.7. HABs and Climate Change

- Because the growth, toxicity, and distribution of harmful algal bloom (HAB) species are all tied to the environment, changes in climate can change the occurrence, severity, and impacts of HAB events.

4.5. WET LAND ECOSYSTEM

- Wetlands are areas intermediate in character between deepwater and terrestrial habitats, also transitional in nature, and often located between them.
- These habitats experience periodic flooding from adjacent deepwater habitats and therefore supports plants and animals specifically adapted to such shallow flooding or water logging of the substrate, were designated as wetlands.
- They included lake littorals (marginal areas between highest and lowest water level of the lakes), floodplains (areas lying adjacent to the river channels beyond the natural levees and periodically flooded during high discharge in the river) and other marshy or swampy areas where water gets stagnated due to poor drainage or relatively impervious substrata & Bogs, fens and mangroves due to similar ecological characteristics

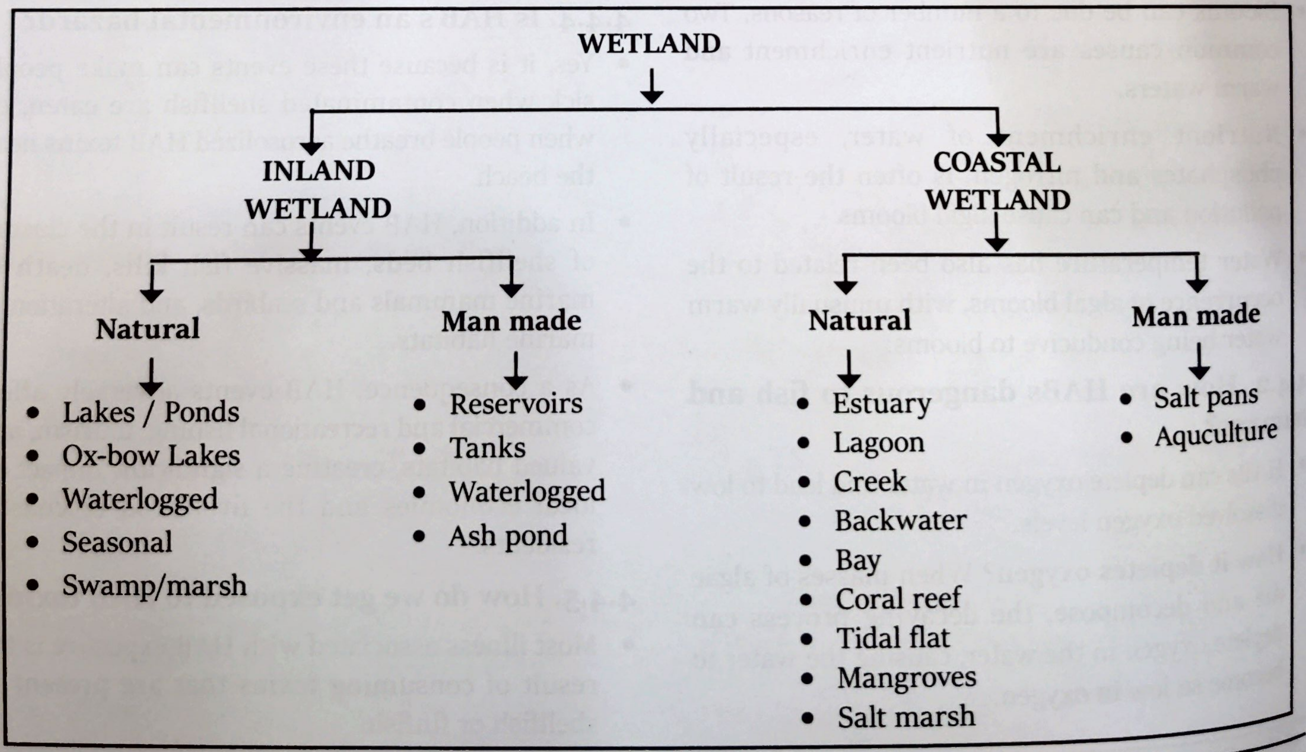
4.5.1. Definition

- Areas of marsh, fen, peatland/water, whether natural (or) artificial, permanent (or) temporary with water that is static (or) flowing, fresh, brackish (or) salt, including areas of marine water the depth of which at low tide does not exceed 6 mtrs.

4.5.2. Characteristics

- Covered by water (or) has waterlogged soil for atleast seven days during the growing season.
- Adopted plant life (hydrophytes)
- Hydric soils (not enough O2 available for some plants)

4.5.3. Wetlands Classification



4.5.4. Criteria for Identification of Wetlands of National Importance

- Criteria for identification of wetlands of national importance under NWCP are same as those prescribed under the 'Ramsar Convention on Wetlands' and are as given below:
- Sites containing representative, rare or unique wetland types

(i) If it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.

- Criteria based on species and ecological communities

(ii) If it supports vulnerable, endangered, or critically endangered species; or threatened ecological communities.

(iii) If it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.

(iv) If it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.

- Specific criteria based on water birds

(v) If it regularly supports 20,000 or more water birds.

(vi) If it regularly supports 1% of the individuals in a population of one species or subspecies of waterbirds.

- Specific criteria based on fish

(vii) If it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.

(viii) If it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend. Specific criteria based on water/life and culture

(ix) If it is an important source of food and water resource, increased possibilities for recreation and eco-tourism, improved scenic values, educational opportunities, conservation of cultural heritage (historic or religious sites).

4.5.5. Functions of Wetlands

- Habitat to aquatic flora and fauna, as well as numerous species of birds, including migratory species.
- Filtration of sediments and nutrients from surface water
- Nutrients recycling
- Water purification
- Floods mitigation
- Maintenance of stream flow
- Ground water recharging
- Provide drinking water, fish, fodder, fuel, etc
- Control rate of runoff in urban areas
- Buffer shorelines against erosion
- Comprise an important resource for sustainable tourism, recreation and cultural heritage
- Stabilization of local climate
- Source of livelihood to local people
- Genetic reservoir for various species of plants (especially rice)
- Supporting specific diversity

4.5.6. Reasons for depletion

- Conversion of lands for agriculture
- Overgrazing
- Removal of sand from beds
- Aqua culture
- Habitat Destruction and Deforestation
- Pollution
- Domestic waste
- Agricultural runoff
- Industrial effluents
- Climate change

4.5.7. Mitigation

- Survey and demarcation
- Protection of natural regeneration
- Artificial regeneration
- Protective measures
- Afforestation (percentage survival to be indicated)
- Weed control
- Soil conservation measures & afforestation
- Wildlife conservation
- Removal of encroachments
- Eutrophication abatement
- Environmental awareness

4.5.8. Comparison between Lake and Wetlands

Sl . no	Characteristic	Lake	Wetland (shallow lake)
1.	Origin	various process	Fluvial/Geomorphic processes
2.	Water turnover	Permanent	Permanent or Temporary
3.	Water level changes	relatively small	Relatively Large
4.	Littoral: Pelagial ratio	Small	Large
5.	Thermal stratification	Yes	No
6.	Vertical mixing	Thermally regulated	Wind regulated
7.	Dominant Producer	Phyto plankton	Macrophytes
8.	Food chain	Grazing Pathway	Detritus Pathway
9.	Nutrient Cycles	Microbial loops less important	Microbial loop dominant
10.	Productivity	Low	High
11.	Trophic status	Oligo trophic	Mostly Eutrophic (Except desirable in bogs)
12.	Biodiversity	Generally low	Generally high
13.	Functions- Flood control	Less Significant	Significant
14.	Groundwater recharge	Negligible /low	Low-high
15.	Waste treatment	No	Yes
16.	Management objectives	Control of eutrophication High Water quality	Biodiversity conservation Specific Functions

4.5.9. India's Wetlands

- Wetlands are areas of critical ecological significance: as they support biodiversity, support millions of people directly and indirectly, protect from storms, flood control, improve water quality, supply food, fiber and raw materials.
- India has totally 27,403 wetlands, of which 23,444 are inland wetlands and 3,959 are coastal wetlands. Wetlands occupy 18.4% of the country's area of which 70% are under paddy cultivation.
- India has nearly 4.6% of its land as wetlands, covering an area of 15.26 million hectares and has 75 sites designated as Wetlands of International Importance (Ramsar Sites), with a surface area of 1.093 million hectares.
- Natural wetlands in India range from high altitude wetlands in Himalayas; flood plains of the major

river systems; saline and temporary wetlands of the arid and semi-arid regions; coastal wetlands such as lagoons, backwaters, estuaries, mangroves, swamps and coral reefs, and so on.

4.6 WETLAND: ACTS AND POLICIES

4.6.1. National Lake Conservation Plan (NLCP)

- Ministry of Environment and Forests has been implementing the National Lake Conservation Plan (NLCP) since 2001 for conservation and management of polluted and degraded lakes in urban and semi-urban areas

Objective

- to restore and conserve the urban and semi-urban lakes of the country degraded due to waste water discharge into the lake and other unique freshwater eco systems, through an integrated ecosystem approach.

Activities Covered Under NLCP

- Prevention of pollution from point sources by intercepting, diverting and treating the pollution loads entering the lake. The interception and diversion works may include sewerage & sewage treatment for the entire lake catchment area.
  - (i) In situ measures of lake cleaning such as de-silting, de-weeding, bioremediation, aeration, bio-manipulation, nutrient reduction, with-drawal of anoxic hypolimn ion, constructed wetland approach or any other successfully tested eco-technologies etc depending upon the site conditions.
  - (ii) Catchment area treatment which may include afforestation, storm water drainage, silt traps etc.
  - (iii) Strengthening of bund, lake fencing, shoreline development etc.
  - (iv) Lake front eco-development including public interface.
  - (v) Solid waste management2 & provision of dhobi ghats is generally not covered under NLCP.
  - (vi) Prevention of pollution from non-point sources by providing low cost sanitation.
  - (vii) Public awareness and public participation.
  - (viii) Capacity building, training and research in the area of Lake Conservation.
  - (ix) Any other activity depending upon location specific requirements

4.6.2. National Wetlands Conservation Programme (NWCP)

- NWCP was implemented in the year 1985-86.
- Under the programme, 115 wetlands (Annexure) have been identified by the Ministry which require urgent conservation and management interventions.

Aim

- Conservation of wetlands to prevent their further degradation and ensuring their wise use for the benefit of local communities and overall conservation of biodiversity.

Objectives

- to lay down policy guidelines for conservation and management of wetlands in the country.
- to provide financial assistance for undertaking intensive conservation measures in the identified wetlands.
- to monitor implementation of the programme; and to prepare an inventory of Indian wetlands.
- The Central Government is responsible for overall coordination of wetland conservation programmes and initiatives at the international and national levels. It also provides guidelines, financial & technical assistance to state govt.
- Since the land resources belong to them, the State Governments/UT Administration are responsible for management of wetlands and implementation of the NWCP for ensuring their wise-use.

4.6.3. Centre for Wetland Conservation and Management

- MoEF & CC established a Centre for Wetland Conservation and Management (CWCM), as a part of the National Centre for Sustainable Coastal Management (NCSCM), Chennai, an institution under the Ministry.

- The Centre will help in building partnership and networks with relevant national and international agencies.
- The Centre would also assist the national and State/ UT Governments in the design and implementation of policy and regulatory frameworks, management planning, monitoring and targeted research for its conservation.

4.6.4. Wetlands (Conservation and Management) Rules 2017

Wetlands (Conservation and Management) Rules, 2017 supersede the Wetlands (Conservation and Management) Rules, 2010 for effective conservation and management of wetlands in the country

Key features

Decentralisation of wetland management. Under the new rules, the powers have been given to the State governments so that protection and conservation can be done at the local level. The central government has mainly retained powers regarding monitoring.

The new rules have replaced the Central Wetlands Regulatory Authority (CWRA) with the National Wetland Committee, which has a merely advisory role.

The State or UT Wetlands Authority will have to prepare a list of all wetlands and also will develop a comprehensive list of activities to be regulated and permitted within notified wetlands and their zone of influence.

The new rules also prohibit encroachments on wetlands, solid waste dumping, discharge of untreated waste and effluents from industries and human settlements.

It prescribes that conservation and management would be based on the principle of wise use, which is to be determined by the Wetlands Authority.

Shortfalls

We have earlier read the definition of wetland given by Ramsar convention earlier in this topic. The 2010 wetland rules followed the definition of Ramsar convention.

However, the 2017 rules, in the definition of wetland do not include river channels, paddy fields, man-made water bodies/tanks specifically for drinking water purposes and structures specifically constructed for aquaculture, salt production, recreation, and irrigation purposes.

By this new definition (exclusion of aforesaid wetlands) close to 65 % wetland in the country will lose the status of wetlands. The management and protection awarded to river channels, man-made wetlands will be no more effective as they are not considered wetlands.

The definition of wetlands and its inclusion is done by the respective state/ UT. This may lead to a lack of uniformity in defining and conserving the wetlands in the country.

The older provision of appealing to the National Green Tribunal does not exist in the 2017 Rules.

There is also no timeline specified for phasing out solid waste and untreated waste from being dumped into wetlands.

The new rules do not take into account the Jagpal Singh vs State of Punjab (2011) judgment of Supreme Court for the restoration of encroached wetlands throughout the country.

Key to wetland conservation is not just understanding regimes of multiple uses but conserving and managing the integrity of the wetland ecosystem.

4.6.5. National Plan for Conservation of Aquatic Ecosystems (NPCA)

- NPCA stands as a unified conservation program encompassing both wetlands and lakes.
- This centrally sponsored initiative is presently under the administration of the Union Ministry of Environment and Forests (MoEF).

- Its inception in 2015 resulted from the amalgamation of the National Lake Conservation Plan and the National Wetlands Conservation Programme.
- The Government has identified 130 wetlands for priority restoration in the next five years and asked states to submit their respective integrated management plan.
- Each of these wetlands will be restored under a comprehensive scheme of the National Plan for Conservation of Aquatic Ecosystems (NPCA) for conservation and restoration of wetlands and lakes.
- The overarching goal of NPCA is to enhance coordination and prevent redundancy in administrative functions.

4.6.6. Amrit Darohar Scheme

- The 2023-24 budget unveiled a three-year plan that underscores the importance of wetlands and seeks to promote their effective utilization.
- At its core, this initiative empowers local communities to play a central role in wetland conservation.
- The primary goals of the program encompass enhancing wetland biodiversity, safeguarding and increasing carbon storage, harnessing eco-tourism potential, and enabling local communities to maximize wetland utilization for employment opportunities.

4.7. ESTUARY ECOSYSTEM

- Estuaries are located where river meets the sea. Estuaries are water bodies where the flow of freshwater from river mixes with salt water transported, by tide, from the ocean. Estuaries are the most productive water bodies in the world. They are located at the lower end of a river and are subject to tidal fluctuations.
- Estuaries are either once or twice, daily washed by the seawater.

4.7.1. Characters

- An Estuary is a semi enclosed coastal body of water with one or more rivers or streams flowing into it.
- It has a free connection with open sea.
- The complete salinity range from 0-35 ppt is seen from the head (river end) to the mouth (sea end) of an estuary.
- An estuary has very little wave action, so it provides a calm refuge from the open sea. It provides the shelter for some of the animals.
- It is the most productive region as it receives the high amount of nutrients from fresh and marine water.
- Estuaries are most heavily populated areas throughout the world, with about 60% of the world's population living along estuaries and the coast.

Coastal lakes which have their connection with the sea through small openings are better known as lagoons or backwaters. They exhibit a gradient in salinity from freshwater to marine depending upon the extent of influence of the sea water.

Estuary Formation:

Most estuaries can be grouped into four geomorphic categories based on the physical processes responsible for their formation:

(1) rising sea level; (2) movement of sand and sandbars; (3) glacial processes; and (4) tectonic processes.

- Estuaries are typically classified by their geomorphological features or by water circulation patterns and can be referred to by many different names, such as bays, harbors, lagoons, inlets, etc.

- The banks of estuarine channels form a favoured location for human settlements, which use the estuaries for fishing and commerce, but nowadays also for dumping civic and industrial waste.
- Estuaries are usually biologically highly productive zones.
- They also act as a filter for some dissolved constituents in river water; these precipitate in the zone where river water meets seawater.
- More important is the trapping of suspended mud and sand carried by rivers which leads to delta formations around estuaries.

4.7.2. A Healthy Estuary

- A healthy estuary supports a host of plants and animals. It stores and recycles Nutrients, traps sediment and forms a buffer between coastal catchments and the marine environment. It also absorbs traps and detoxifies pollutants, acting as a natural water filter. When all such processes remain functional an estuary is considered to be healthy state.
- Estuaries support diverse habitats, such as mangroves, salt marshes, sea-grass, mudflats etc.

4.7.3. Life in Estuary

- Only certain types of plants and animals specially adapted to the "brackish" estuarine waters flourish in the estuaries. Factors influencing the growth and distribution of organism in an estuary are its salinity and the amount of flooding.
- Estuaries are homes to all kind of terrestrial or land-based plants and animals, such as wood storks, pelicans, coniferous and deciduous trees and butterflies. Estuaries are also homes to unique aquatic plants and animals, such as sea turtles and sea lions, sea catfish, saltworts, eelgrass, saltgrasses, cordgrasses, sea grass, sedge and bulrush.
- Predators are important to the estuary because of their end position in most consumer food chains.

4.7.4. Benefits of Estuarine Ecosystem

- Water quality regulation and groundwater recharge
- Habitat, breeding and nursery grounds for plants and animals
- Biological productivity
- Social Benefits
- Community values
- Indigenous values
- Recreation values
- Knowledge/Research values
- Economic Benefits
- Commercial fishing
- Ports and harbours
- Navigation
- Tourism
- Agriculture, aquaculture and industry
- Storm and erosion protection

4.7.5. India Estuarine Ecosystem

- The Country has 14 major, 44 medium and 162 minor rivers drains into the sea through various estuaries.
- Estuaries are an important and distinct component of the coastal landscape with highly complex ecosystems, varying physical – chemical properties and having highly diverse flora and fauna.
- Major estuaries occur in the Bay of Bengal. Many estuaries are locations of some of the major seaports.
- Most of the India's major estuaries occur on the east coast. In contrast, the estuaries on the west coast are smaller.

4.7.6. Issues of Indian Estuarine Ecosystem

- The specific issues which have affected the estuarine environment in the country are:

1. Water flow

- Changes in water flow in various estuaries, either far in excess or much lower than required (e.g., Hooghly, Narmada, Krishna, Godavari, Pulicat etc.)

- Modifications of the estuarine catchments (e.g Most of the Indian estuaries)

2. Pollution & Water Quality

- Pollution through industries and combined city sewage (e.g., all the Indian estuaries)

3. Recreation And Tourism

- Recreational boating (e g., Hooghly WB; Chilika, Orissa)
- Recreational fishing kg., Chilika)
- Navigation (e g., Hooghly)

4. Ports & Shipping

- Dredging (e.g., Hooghly)
- Shipping (r g., Hooghly)

5. Land-use

- Expansion of urban and rural settlements (e.g, Hooghly, Krishna, Cauvery, Pulicat)
- Marinas, groynes, land reclamation and other structures (e.g., Hooghly, Pulicat)
- Mining & Industries (e.g., Hooghly, Zuari, Goa)
- Agriculture (e.g., all the Estuaries)
- Dumping of solid wastes (eg. all the Indian estuaries)

6. Commercial Fishing & Aquaculture

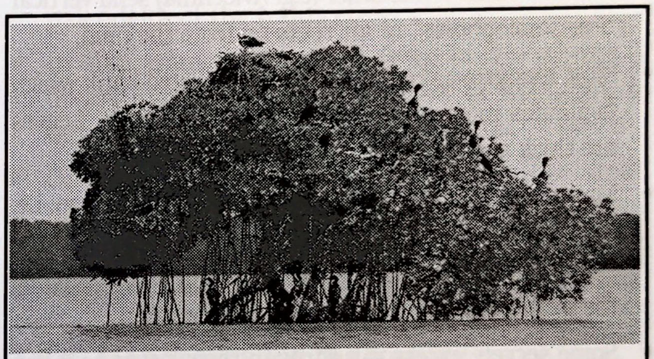
- Over exploitation of target fish stock due to increased demand (e.g., all the Indian estuaries)
- Reclaiming the fringed areas for intensive aquaculture in pens ,
- obstructing the migratory routes of fish and prawn recruitment (e.g., Chilika, Pulicat)
- Polluting the environment through feeding of stocked fish and prawn in pens (Chilika)
- Destruction of biodiversity through prawn seed collection and operation of small-meshed nets (e.g., Hooghly, Chilika, Pulicat)

7. Climate Change

- Submergence of catchment areas due to rise in water level (e.g., all the major Indian estuaries)
- Change in biodiversity profile, affecting the production and productivity (e.g., all the major Indian estuary)

4.8. MANGROVES

- Mangroves are the characteristic littoral plant formation of tropical and subtropical sheltered coastlines. Mangroves are trees and bushes growing below the high water level of spring tides which exhibits remarkable capacity for salt water tolerance. - FAO .



Mangrove tree

4.8.1. Characteristics of mangroves

- They are basically evergreen land plants growing on sheltered shores, typically on tidal flats, deltas, estuaries, bays, creeks and the barrier islands.
- The best locations are where abundant silt is brought down by rivers or on the backshore of accreting sandy beaches.
- Their physiological adaptation to salinity stress and to water logged anaerobic mud is high.
- They require high solar radiation and have the ability to absorb fresh water from saline/brackish water.
- It produces pneumatophores (blind roots) to overcome respiration problem in the anaerobic soil conditions.

Pneumatophores

- Mangroves occur in variety of configurations. Some species (e.g. Rhizophora) send arching prop roots down into the water. While other (e.g. Avicennia) send vertical "Pneumatophores" or air roots up from the mud.
- Most mangrove vegetation has lenticellated bank which facilitates more water loss, produces coppices. Leaves are thick and contain salt secreting glands.
- Mangroves exhibit Viviparity mode of reproduction. i.e. seeds germinate in the tree itself (before falling to the ground). This is an adaptative mechanism to overcome the problem of germination in saline water.
- Some secrete excess salt through their leaves as if you look closely, you can see crystals of salt on the back of the leaves; others block absorption of salt at their roots.
- Adventitious roots which emerged from the main trunk of a tree above ground level are called stilt roots.

Stilt Roots

4.8.2. Role of mangroves

- Mangrove plants have (additional) special roots such as prop roots, pneumatophores which help to impede water flow and thereby enhance the deposition of sediment in areas (where it is already occurring), stabilize the coastal shores, provide breeding ground for fishes.
- Mangroves moderate monsoonal tidal floods and reduce inundation of coastal lowlands.
- It prevents coastal soil erosion.
- It protects coastal lands from tsunami, hurricanes and floods.
- Mangroves enhance natural recycling of nutrients.
- Mangrove supports numerous flora, avifauna and wild life.
- Provide a safe and favorable environment for breeding, spawning, rearing of several fishes.
- It protects coastal inland from adverse climatic elements.
- It supplies woods, fire wood, medicinal plants and edible plants to local people.
- It provides numerous employment opportunities to local communities and augments their livelihood.

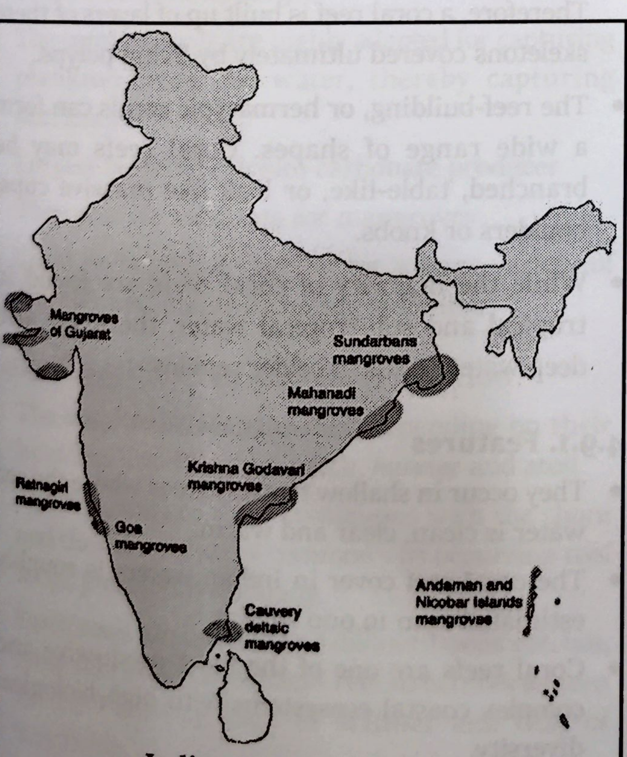
Fine, anoxic sediments deposited under mangroves act as sinks for a variety of heavy (trace) metals which are scavenged from the overlying seawater by colloidal particles in the sediments. By cleaning our air, they taking in carbon dioxide, storing the carbon in their roots, leaves, branches and in its surrounding silt, and release oxygen back to the atmosphere, along with a little methane gas.

4.8.3. Threat

- They are destroyed for conversion of area for agricultural purpose, fuel, fodder and, salinization, minig, oil spills, aquacultural (shrimp farming), use of chemical pesticides & fertilizers, industrial purposes.

4.8.4. Mangrove profile in India

- The mangroves of Sundarbans are the largest single block of tidal holophytic mangroves of the world. The major species of this dense mangrove forest include Herritiera fames, Rhizophora spp., Bruguiera spp., Ceriops decandra, Sonneratia spp. and Avicennia spp., Nypa fruticans are found along the creeks. This mangrove forest is famous for the Royal Bengal Tiger and crocodiles. Mangrove areas are being cleared for agricultural use.
- The mangroves of Bhitarkanika (Orissa), which is the second largest in the Indian sub continent, harbour high concentration of typical mangrove species and high genetic diversity.
- Mangrove swamps occur in profusion in the intertidal mudflats on both side of the creeks in the Godavari-Krishna deltaic regions of Andhra Pradesh.
- Mangroves of Pichavaram and Vedaranyam are degraded mainly due to construction of aquaculture ponds and salt pans.



Indian Mangrove Profile

- On the west coast of India, mangroves, mostly scrubby and degraded occur along the intertidal region of estuaries and creeks in Maharashtra, Goa and Karnataka.
- The mangrove vegetation in the coastal zone of Kerala is very sparse and thin.
- In Gujarat (north-west coast) mangroves Avicennia marine, Avicennia officinalis and Rhizophora mucronata are found mainly in Gulf of Kachchh and the Kori creek.
- Mangroves are of scrubby type with stunted growth, forming narrow, discontinuous patches on soft clayey mud.
- The condition of the mangroves is improving especially in the Kori creek region, which is a paleodelta of the Indus river.
- In size, mangroves range from bushy stands of dwarf mangroves found in Gulf of Kuchchh, to taller stands found in the Sunderbans.
- On the Andaman & Nicobar Islands, the small tidal estuaries, neritic inlets and the lagoons support a dense and diverse undisturbed mangrove flora.

4.8.5. Mangroves for the Future

- Mangroves for the Future are a partnership-based initiative promoting investment in coastal ecosystems for sustainable development.

Mission

- to promote healthy coastal ecosystems through a partnership-based, people-focused, policy-relevant and investment-orientated approach, which builds and applies knowledge, empowers communities and other stakeholders, enhances governance, secures livelihoods, and increases resilience to natural hazards and climate change.
- Member countries: India, Indonesia, Maldives, Pakistan, Seychelles, Sri Lanka, Thailand, Viet Nam. Outreach countries: Bangladesh, Cambodia, Myanmar, Timor-Leste. Dialogue countries: Kenya, Malaysia, Tanzania.
- MFF provides a collaborative platform to help countries, sectors and agencies in the MFF region

tackle the growing challenges to coastal sustainability.

- MFF has adopted mangroves as its flagship ecosystem in recognition of the important role that mangrove forests played in reducing the impact of the 2004 Indian Ocean tsunami, and the severe effect on coastal livelihoods caused by the loss and degradation of mangroves.
- However MFF embraces all coastal ecosystems, including coral reefs, estuaries, lagoons, wetlands, beaches and seagrass beds.

4.8.6. MISHTI scheme

- The scheme is known as the "Mangrove Initiative for Shoreline Habitats and Tangible Incomes."
- Within this initiative, both MGNREGA and CAMPA funds will be utilized to create meaningful employment opportunities for individuals, all while concurrently expanding mangrove plantations along the coastlines and in saltpans across the country.

4.9. CORAL REEFS

- Coral is actually a living animal. Coral has a symbiotic relationship (each gives something to the other and gets something back in return) with 'zooxanthellae' microscopic algae which live on coral [i.e. instead of living on the sea floor, the algae lives up on the coral which is closer to the ocean surface and so that the algae gets adequate light].

Coral

- Zooxanthellae assist the coral in nutrient production through its photosynthetic activities. These activities provide the coral with fixed carbon compounds for energy, enhance calcification ,and mediate elemental nutrient flux.
- The tissues of corals themselves are actually not the beautiful colors of the coral reef, but are instead clear (white). The corals receive their coloration from the zooxanthellae living within their tissues.
- The host coral polyp in return provides its zooxanthellae with a protected environment to live within, and a steady supply of carbon dioxide for its photosynthetic processes.
- There are two types of corals: hard corals and soft corals, such as sea fans and gorgonians. Only hard corals build reefs.
- The builders of coral reefs are tiny animals called polyps. As these polyps thrive, grow, then die, they leave their limestone (calcium carbonate) skeletons behind. The limestone is colonized by new polyps. Therefore, a coral reef is built up of layers of these skeletons covered ultimately by living polyps.
- The reef-building, or hermatypic corals can form a wide range of shapes. Coral reefs may be branched, table-like, or look like massive cups, boulders or knobs.
- While the majority of coral reefs are found in tropical and sub-tropical water, there are also deep water corals in colder regions.

4.9.1. Features

- They occur in shallow tropical areas where the sea water is clean, clear and warm.
- The coral reef cover in Indian waters is roughly estimated upto 19,000 sq. Km.
- Coral reefs are one of the most productive and complex coastal ecosystems with high biological diversity.

- The high productivity is owing to the combination of its own primary production and support from its surrounding habitat.
- Reef building corals are a symbolic association of polyps (coral animals) and 'zooxanthellae' (the microscopic algae)
- The corals are generally slow growing colonies of animals while zooxanthellae are fast growing plants.
- Even though corals live in nutrient poor waters, their capability to recycle the scarce nutrients (by the whole nutrient community) is enormous.
- In coral reef ecosystem, many invertebrates, vertebrates, and plants live in close association to the corals, with tight resource coupling and recycling, allowing coral reefs to have extremely high productivity and biodiversity, such that they are referred to as 'the Tropical Rainforests of the Oceans'.

4.9.2. Functions of Coral Reefs

- Coral reefs are natural protective barriers against erosion and storm surge.
- The coral animals are highly adapted for capturing plankton from the water, thereby capturing nutrients
- Largest biogenic calcium carbonate producer
- They provide substrate for mangroves
- Coral reefs provide habitat for a large variety of animals and plants including avifauna.

4.9.3. Classification and their location

- The coral reefs are classified depending on their locations into fringing, patch, barrier and atoll.
- The fringing reefs are contiguous with the shore and they are the most common - by occurring reef form, found in Andamans.
- Patch reefs are isolated and discontinuous patches, lying shoreward of offshore reef structures as seen in the Palk bay, Gulf of Mannar and Gulf of Katchchh.
- Barrier reefs are linear offshore reef structures that run parallel to coastlines and arise from submerged shelf platforms. The water body between the reef and the shore is termed as lagoon. Barrier reefs are seen in Nicobar and Lakshadweep.
- Atolls are circular or semi circular reefs that arise from subsiding sea floor platforms as coral reef building keeps ahead of subsidence. The examples are the atolls of Lakshadweep and Nicobar.
- When the reef building do not keep pace with subsidence, reefs become submerged banks as seen in Lakshadweep.
- Sea grasses grow on Kavaratti atoll, mangroves are prevalent on Andaman and Nicobar coral reefs.
- Among the four major reef areas of India, Andaman and Nicobar Islands are found to be very rich in species diversity followed by the Lakshadweep Islands, the Gulf of Mannar and finally the Gulf of Kachchh.

Cold Water Corals:

- Cold-water corals inhabit deep, cold (39-55 degrees F), water. The United Nations Environment Programme reports that there are more cold-water coral reefs worldwide than tropical reefs.
- There are only about 6 different coral species associated in building with these reefs. The largest cold-water coral reef is the Rost Reef off Norway.

4.9.4. Threat

1. Natural causes may be due to the outbreak of reef destroying mechanisms, "bleaching" and depletion of essential symbiotants.
2. Anthrogenic causes – may be due to chemical pollution (pesticides, cosmetics, etc), industrial pollution, mechanical damage, nutrient loading or sediment loading, Dredging, shipping, tourism,

mining or collection, thermal pollution, intensive fishing,etc.

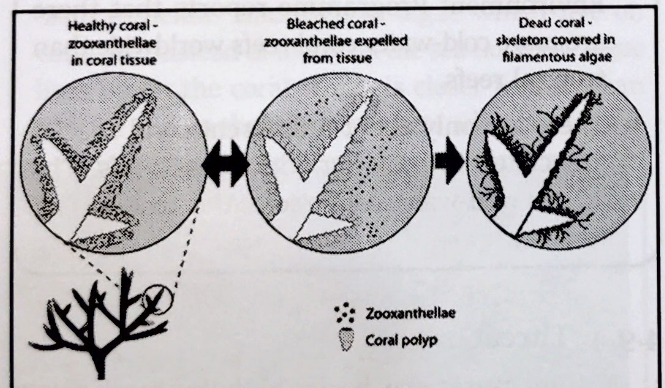
- Coral reef ecosystems world-wide have been subject to unprecedented degradation over the past few decades. Disturbances affecting coral reefs include anthropogenic and natural events. Recent accelerated coral reef decline seems to be related mostly to anthropogenic impacts (overexploitation, overfishing, increased sedimentation and nutrient overloading. Natural disturbances which cause damage to coral reefs include violent storms, flooding, high and low temperature extremes, El Nino Southern Oscillation (ENSO) events, subaerial exposures, predatory outbreaks and epizootics.
- Coral reef bleaching is a common stress response of corals to many of the various disturbances mentioned above.

4.9.5. Coral Bleaching

- Bleaching, or the paling of coral colour occurs when

(i) the densities of zooxanthellae decline and / or

(ii) the concentration of photosynthetic pigments within the zooxanthellae fall.


Healthy coral - zooxanthellae in coral tissue
Bleached coral - zooxanthellae expelled from tissue
Dead coral - skeleton covered in filamentous algae
Zooxanthellae
Coral polyp

Coral Bleaching

- When corals bleach they commonly lose 60-90% of their zooxanthellae and each zooxanthella may lose 50-80% of its photosynthetic pigments.
- If the stress-causing bleaching is not too severe and if it decreases in time, the affected corals usually regain their symbiotic algae within several weeks or a few months.
- If zooxanthellae loss is prolonged, i.e. if the stress continues and depleted zooxanthellae populations do not recover, the coral host eventually dies.
- High temperature and irradiance stressors have been implicated in the disruption of enzyme systems in zooxanthellae that offer protection against oxygen toxicity.
- Photosynthesis pathways in zooxanthallae are impaired at temperatures above 30 degrees C, this effect could activate the disassociation of coral / algal symbiosis.
- Low- or high-temperature shocks results in zooxanthellae low as a result of cell adhesion dysfunction.
- This involves the detachment of cnidarian endodermal cells with their zooxanthellae and the eventual expulsion of both cell types.

4.9.6. Ecological causes of coral bleaching

- As coral reef bleaching is a general response to stress, it can be induced by a variety of factors, alone or in combination. It is therefore difficult to unequivocally identify the causes for bleaching events. The following stressors have been implicated in coral reef bleaching events.

Temperature (Major Cause)

- Coral species live within a relatively narrow temperature margin, and anomalously low and high sea temperatures can induce coral bleaching. Bleaching is much more frequently reported from elevated sea water temperature. Bleaching events also occur during sudden temperature drops accompanying intense upwelling episodes, seasonal cold-air outbreaks.

Solar Irradiance

- Bleaching during the summer months, during seasonal temperature and irradiance maxima often occurs disproportionately in shallow-living corals and on the exposed summits of colonies.

Solar radiation has been suspected to play a role in coral bleaching. Both photosyntheticaly active radiation (PAR, 400-700nm) and ultraviolet radiation (UVR, 280-400nm) have been implicated in bleaching.

Subaerial Exposure

- Sudden exposure of reef flat corals to the atmosphere during events such as extreme low tides, ENSO-related sea level drops or tectonic uplift can potentially induce bleaching.

Sedimentation

- Relatively few instances of coral bleaching have been linked solely to sediment. It is possible, but has not been demonstrated, that sediment loading could make zooxanthellate species more likely to bleach.

Fresh Water Dilution

- Rapid dilution of reef waters from storm-generated precipitation and runoff has been demonstrated to cause coral reef bleaching. Generally, such bleaching events are rare and confined to relatively small, nearshore areas.

Inorganic Nutrients

- Rather than causing coral reef bleaching, an increase in ambient elemental nutrient concentrations (e.g. ammonia and nitrate) actually increases zooxanthellae densities 2-3 times. Although eutrophication is not directly involved in zooxanthellae loss, it could cause secondary adverse affects such as lowering of coral resistance and greater susceptibility to diseases.

Xenobiotics

- Zooxanthellae loss occurs during exposure of coral to elevated concentrations of various chemical contaminants, such as Cu, herbicides and oil. Because high concentrations of xenobiotics are required to induce zooxanthellae loss, bleaching from such sources is usually extremely localized and / or transitory .

Epizootics

- Pathogen induced bleaching is different from other sorts of bleaching. Most coral diseases cause patchy or whole colony death and sloughing of soft tissues, resulting in a white skeleton (not to be confused with bleached corals). A few pathogens have been identified the cause translucent white tissues, a protozoan.

4.9.7. Global Coral Reef R&D Accelerator Platform

- The Global Coral Reef R&D Accelerator Platform is an innovative action-oriented initiative aimed at creating a global research and development (R&D) program to advance research, innovation and capacity building in all facets of coral reef conservation, restoration, and adaptation, and strengthen ongoing efforts and commitments made to enhance coral reefs conservation and their further degradation.

4.10. GOVERNMENT MEASURES TO PROTECT MANGROVE FOREST AND CORAL REEFS (OR COASTAL ECOSYSTEM)

- The Government seeks to protect, sustain and augment mangroves and coral reef in the country by both regulatory and promotional measures.
- Under the regulatory measures, the Coastal Regulation Zone (CRZ) Notification (2011) and the Island Protection Zone (IPZ) Notification 2011 regulates the development activities along the Sea coast and tidal influenced water bodies.
- The mangroves and coral reefs areas are categorized as ecological sensitive areas (CRZ-I) where no new constructions are permitted except projects relating to Department of Atomic Energy; pipelines, conveying systems including transmission lines; installation of weather radar for monitoring of cyclones movement and prediction by Indian Meteorological Department and construction of trans harbour sea link and without affecting the tidal flow of water.

- To enforce and implement the CRZ and IPZ Notifications, the Ministry of Environment and Forests has constituted the National and State/UT level Coastal Zone Management Authorities.

The Ministry of Environment & Forests also provides financial assistance to Coastal States/Union Territories, who so request, under its Centrally Sponsored Scheme for conservation and management of mangroves and coral reef.

- In addition Coral reef is included in Schedule I of the Wild Life Protection Act, 1972 which affords it the highest degree of protection.
- Further Protected Areas, viz.4 National Parks, 96 Sanctuaries and 3 Marine Biosphere Reserve have been created all over the country under the provisions of the Wild Life (Protection) Act, 1972 to conserve marine life including coral reef.
- The Wildlife Crime Control Bureau has also been set up to strengthen the enforcement of law for control of poaching and illegal trade in wildlife and its products.

4.11 COASTAL REGULATION ZONE

CRZ notification was issued in 1991 with the objective to protect the coastal zone and regulate the development activities. It got amended in 2011 and again in 2018. CRZ has four zones: CRZ-I (ecological sensitive),CRZ-II (built-up area), CRZ-III (Rural area) and CRZ-IV (water area).

CRZ-I

(i) Ecologically sensitive areas and the geomorphological features that play aprimary role in maintaining the integrity of the coast.

- Mangroves, in case mangrove area is more than 1000 square metres, a bufferarea of 50 metres shall be provided;
- Corals and coral reefs and associated biodiversity;
- Sand Dunes;
- Mudflats which are biologically active;
- National parks, marine parks, sanctuaries, reserve forests, wildlife habit at sand other protected areas under the provisions of Wild Life (Protection) Act, 1972, the Forest (Conservation) Act, 1980 or Environment (Protection) Act, 1986; including Biosphere Reserves encompassing;
- Salt Marshes;
- Turtle nesting grounds;
- Horse shoe crabs habitats;
- Sea grass beds;
- Nesting grounds of birds;
- Areas or structures of archaeological importance and heritage sites;

(ii) The area between Low Tide Line and High Tide Line.

CRZ-II

The areas which are developed upto or close to the shoreline and falling within municipal limits.

CRZ-III

The areas that are relatively undisturbed and do not fall under either in Category I or II and also include rural and urban areas that are not substantially developed.

CRZ-IV

The aquatic area from low tide line upto territorial limits including the area of the tidal influenced water body.

Significant provisions in the Coastal RegulationZone Notification, 2011

(i) The entire water area which includes 12 nautical miles in the sea and theentire water area of a tidal water body such as creek, river, estuary will be regulated by the Notification.

(ii) In order to safeguard livelihood and property of local communities including the infrastructure along the coastal areas the hazard line has been introduced which will be demarcated by the offices of the Survey of India.

(iii) Keeping in view the environmental and social issues, special dispensation has been provided to Greater Mumbai, Kerala, Goa and Critically Coastal Vulnerable Areas such as the Sunderban.

(iv) In view of the erosion experienced along the coastal areas due to man-made interventions the shoreline will be mapped using up-to-date satellite images and the shorelines will then be subsequently classified as 'high eroding','medium eroding' and 'low or stable stretches'. No foreshore development would be permissible in high eroding areas.

(v) To meet the increasing demands of housing for fishing communities and other traditional coastal communities, the No Development Zone which is of 200 metres from the High Tide Line is being reduced to 100m.

4.11.1. ACTIVITIES PERMITTED AND RESTRICTED IN CRZ

CRZ-I

The activities permitted in CRZ-I under the 2011 Notification are

(i) No new construction shall be permitted in CRZ-I except;

- Projects relating to the Department of Atomic Energy;
- Pipelines, conveying systems including transmission lines;
- Facilities that are essential for activities permissible under CRZ-I;
- Installation of weather radar for monitoring of cyclones movement and prediction by the Indian Meteorological Department;
- Construction of trans-harbour sea link and roads on stilts or pillars without affecting the tidal flow of water, between LTL and HTL.
- Development of green field airport already permitted at only Navi Mumbai;

(ii) Between Low Tide Line and High Tide Line in areas which are not ecologically sensitive, the following may be permitted;

- Exploration and extraction of natural gas;
- Construction of dispensaries, schools, public rain shelter, community toilets, bridges, roads, jetties, water supply, drainage, sewerage which are required to meet the needs of traditional inhabitants living within the biosphere reserves after obtaining approval from concerned CZMA.
- Salt harvesting by solar evaporation of seawater;
- Desalination plants;
- Storage of non-hazardous cargo such as edible oil, fertilizers and food grain within notified ports;
- Construction of trans-harbour sea links, roads on stilts or pillars without affecting the tidal flow of water.

CRZ-II

Buildings are permissible on the landward side of the existing road, authorized structure or hazardous line where there are no authorised structures. Other activities such as desalination plants and storage of non-hazardous cargo are also permissible.

CRZ-III

The provisions of CRZ 3 has undergone changes with the CRZ 2018 notification

CRZ-IV

In CRZ-IV areas, there is no restriction on the traditional fishing and allied activities undertaken by local communities. However, no untreated sewage, effluents or solid waste shall be let off or dumped in these areas. A comprehensive plan for treatment of sewage generating from the city must be formulated.

4.11.2. CRZ Notification, 2018

Dr.ShaileshNayakCommittee (Secretary, Ministry of Earth Sciences) constituted in June 2014 to examine the various issues and concerns of Coastal States/UTs and other stakeholders for recommending appropriate changes in the CRZ Notification, 2011.

Government stated that CRZ Notification, 2018 will meet the aspirations of Coastal communities besides ensuring welfare of poor and vulnerable populations. It will also add to creating additional opportunities for affordable housing and the people at large looking for shelter. Tourism has been one of the greatest creators of livelihood and jobs. The new Notification will boost tourism.

The Notification is so designed that it balances the needs in such a way that both, promoting economic growth and also theconservation principles of coastal regions are fulfilled.

Salient Features:

(i) Allowing FSI as per current norms in CRZ areas: As per CRZ, 2011 Notification, for CRZ-II (Urban) areas, Floor Space Index (FSI) or the Floor Area Ratio (FAR) had been frozen as per 1991 Development Control Regulation (DCR) levels. In the CRZ, 2018 Notification, it has been decided to de-freeze the same and permit FSI for construction projects, as prevailing on the date of the new Notification. This will enable redevelopment of these areas to meet the emerging needs.

(ii) Densely populated rural areas to be afforded greater opportunity for development: For CRZ-III (Rural) areas, two separate categories have now been stipulated as below:

(a) CRZ-III A - These are densely populated rural areas with a population density of 2161 per square kilometre as per 2011 Census. Such areas shall have a No Development Zone (NDZ) of 50 meters from the HTL as against 200 meters from the High Tide Line stipulated in the CRZ Notification, 2011 since such areas have similar characteristics as urban areas.

(b) CRZ-III B - Rural areas with population density of below 2161 per square kilometre as per 2011 Census. Such areas shall continue to have an NDZ of 200 meters from the HTL.

(iii) Tourism infrastructure for basic amenities to be promoted: Temporary tourism facilities such as shacks, toilet blocks, change rooms, drinking water facilities etc. have now been permitted in Beaches. Such temporary tourism facilities are also now permissible in the "No Development Zone" (NDZ) of the CRZ-III areas as per the Notification. However, a minimum distance of 10 m from HTL should be maintained for setting up of such facilities.

(iv) CRZ Clearances streamlined: The procedure for CRZ clearances has been streamlined. Only such projects/activities, which are located in the CRZ-I (Ecologically Sensitive Areas) and CRZ IV (area covered between Low Tide Line and 12 Nautical Miles seaward) shall be dealt with for CRZ clearance by the Ministry of Environment, Forest and Climate Change. The powers for clearances with respect to CRZ-II and III have been delegated at the State level with necessary guidance.

(v) A No Development Zone (NDZ) of 20 meters has been stipulated for all Islands: For islands close to the main land coast and for all Backwater Islands in the main land, in wake of space limitations and unique geography of such regions, bringing uniformity in treatment of such regions, NDZ of 20 m has been stipulated.

(vi) All Ecologically Sensitive Areas have been accorded special importance: Specific guidelines related to their conservation and management plans have been drawn up as a part of the CRZ Notification.

(vii) Pollution abatement has been accorded special focus: In order to address pollution in Coastal areas treatment facilities have been made permissible activities in CRZ-I B area subject to necessary safeguards.

(viii) Defence and strategic projects have been accorded necessary dispensation.

4.12. COASTAL ECOSYSTEMS

4.12.1. Coastal Ocean Monitoring and Prediction System (COMAPS)

- Being implemented from 1991.
- Assesses the health of coastal waters and facilitates management of pollution-related issues
- Programme was restructured and modified in 2000-2001 to include pollution monitoring; liaison, regulation and legislation; and consultancy services.

4.12.2. Land Ocean Interactions in the Coastal Zone (LOICZ)

- Launched in 1995
- Investigates the effects of global change on the coastal zone
- Aims to develop, on a scientific basis, the integrated management of coastal environments

4.12.3. Integrated Coastal and Marine Area Management (ICMAM)

- Launched in 1998
- Aims at integrated management of coastal and marine areas.
- Model plans for Chennai, Goa and Gulf of Kutch being prepared

4.12.4. Institutions for Coastal Management

- India has created institutional mechanisms such as National Coastal Zone Management Authority (NCZMA) and State Coastal Zone Management Authority (SCZMA) for enforcement and monitoring of the CRZ Notification.
- These authorities have been delegated powers under Section 5 of the Environmental (Protection) Act, 1986 to take various measures for protecting and improving the quality of the coastal environment and preventing, abating and controlling environmental pollution in coastal areas.

4.12.5. Integrated Coastal Zone Management

- The concept of ICZM was introduced in 1992 during the Earth Summit at Rio de Janeiro and most of the coastal countries in the World have been adopting ICZM principles for managing their coastal zones.
- With a view to protect and conserve the coastal and marine ecosystems and environment through a holistic coastal management, MoEF & CC launched the Integrated Coastal Zone Management (ICZM) activities in India for a holistic approach with an interactive, dynamic, multidisciplinary, and iterative planning process to promote sustainable development & management of coastal zones through its own wing SICOM.

4.12.6. SICOM

Society of Integrated Coastal Management (SICOM) has been established in 2010 under MoEF&CC with a vision for vibrant, healthy and resilient Coastal and Marine Environment for continuous and enhanced outflow of benefits to the Country and the Coastal Community.

- SICOM acts as Nodal agency for strategic planning, management, execution, monitoring and implementation of Integrated Coastal Zone Management (ICZM) practices in across the country and National Project Management Unit (NPMU) for the ICZM Project and Enhancing Coastal and Ocean Resource Efficiency Project (ENCORE), a world bank project in all the 13 Coastal States/UTs.
- To act as a technical Secretariat to the National Coastal Zone Management Authority (NCZMA) related to regulatory provisions and CRZ classification of coastal stretches of the country.
- SICOM has also embarked upon the Pilot Blue Flag Programme, a first in India under Beach Environment & Aesthetic Management Services (BEAMS) for development of world class Beaches in India
- Capacity building of Coastal State Units in planning, implementation and management of Integrated Coastal Zone Management programs

- Serving as an interface among coastal communities, experts, and governments, including providing with and disseminating examples of best practices and guidelines for coastal and marine ecological security and livelihood security of coastal and island communities

India launched beach cleaning campaign – I-AM-SAVING-MY-BEACH on World Environment Day in 2018 simultaneously at 13 coastal states

International Coastal Cleanup Day was started in 1986 by Linda Maraniss and Kathy O'Hara. They along with ocean lovers organized a Cleanup for Ocean Conservancy. Since then, the Cleanup has grown into an international event in more than 100 countries

4.12.7. BEAMS

In its pursuit of "Sustainable Development" of the coastal regions, SICOM, MoEFCC, launched a flagship program "BEAMS" (Beach Environment & Aesthetics Management Services) under its ICZM (Integrated Coastal Zone Management) project.

The objective of the BEAMS program is to abate pollution in coastal waters & beaches, promote sustainable development of beach amenities/ facilities, protect & conserve coastal ecosystems & natural resources and encourage local authorities & stakeholders to strive and maintain high standards of cleanliness, hygiene, safety and security for beachgoers in accordance with coastal environment norms & regulations.

This program promotes beach tourism and recreation in absolute harmony with nature; and is unique in that sense.

This was aimed at striving for the coveted International eco-label "Blue flag", accorded by The Foundation of Environment Education, FEE Denmark.

4.12.8. 'Blue Flag' certification

- 'Blue Flag' certification is a voluntary award for beaches, marinas, and sustainable boating tourism operators and serves as an eco-label.
- Blue Flag certification is a globally recognised eco-label accorded by non-profit "Foundation for Environment Education in Denmark" based on 33 stringent criteria.
- The Blue Flag programme was started in France in 1985 and in areas out of Europe in 2001. The programme promotes sustainable development in freshwater and marine areas through four main criteria: water quality, environmental management, environmental education and safety.
- It is awarded annually to beaches and marinas in FEE member countries.
- Forty-seven countries currently participate in the program, and 4,573 beaches, marinas, and boats have this certification.
- owners/operators of beaches, marinas and boats are awarded the right to display the Blue Flag

India

- Blue flag certified beaches in india are Kappad (Kerala); Shivrajpur (Gujarat), Ghoghla (Diu), Kasarkod and Padubidri (Karnataka), Rushikonda (Andhra Pradesh), Golden (Odisha) and Radhanagar (Andaman & Nicobar Islands), Kovalam in Tamil Nadu, Eden in Puducherry, Minicoy Thundi in Lakshadweep and Kadmat beach in Lakshadweep.
- The following activities and facilities would be permitted in the CRZ of the beaches, including islands, subject to maintaining a minimum distance of 10 meters from the High Tide Line (HTL):
- They are Portable toilet blocks, change rooms and shower panels; Grey water treatment plant; Solid waste management plant; Solar power plant; Purified drinking water facility; Beach access pathways; Landscaping lighting;Seating benches and sit-out umbrellas; Outdoor play / fitness equipment; CCTV surveillance and control room; First aid station; Cloak room facility; Safety watch towers and beach safety equipment; Beach layout, environment information boards and other

signages; Fencing, preferably vegetative; Parking facilities; Entry gate, tourist facilitation centre; and Other associated facilities or infrastructure, as per requirements of Blue Flag Certification.

These activities and facilities would be exempt from prior clearance under the provisions of CRZ Notification, Island Protection Zone Notification and Island Coastal Regulation Zone Notifications.

4.13 ISLAND PROTECTION ZONE NOTIFICATION, 2011

Why is a separate Island Protection Zone Notification, 2011 required?

There are about 500 islands in Andaman & Nicobar and about 30 in Lakshadweep.These two groups of oceanic islands are home to some of the country's mostthriving biodiversity hotspots. The A&N Islands are known for their terrestrial andmarine biodiversity including forest area which covers 85% of the Andaman andNicobar geographical area, while, Lakshadweep is a coral island. The geographicalareas of these islands are so small that in most of the cases the 500 metresCoastal Regulation Zone regulations overlap. Hence, a separate Notificationis being issued which takes into account the management of the entire island(except for four islands of A&N which include North Andaman, Middle Andaman,South Andaman and Great Nicobar).

The main objectives of the IPZ Notification, 2011are:

- To ensure livelihood security to the fishing communities, tribals and otherlocal communities living in the coastal areas;
- To conserve and protect coastal stretches and;
- To promote development in a sustainable manner based on scientific principles, taking into account the dangers of natural hazards in the coastal areas and sea level rise due to global warming.

4.14. GANGA ACTION PLAN

The Ganga Action Plan was launched on 14th January 1986 with the main objective of pollution abatement, to improve water quality by interception, diversion and treatment of domestic sewage and toxic and industrial chemical wastes present, from identified grossly polluting units entering in to the river.

After reviewing the effectiveness of the "Ganga Action Plan", the Government announced the "Mission Clean Ganga" project on 31st December, 2009 with the objective that by 2020, no municipal sewage and industrial waste would be released in the river without treatment, with the total budget of around Rs.15,000 crore.

The Government also established the National Ganga River Basin Authority (NGRBA), chaired by the Prime Minister, with the objective to ensure effective abatement of pollution and conservation of the river Ganga, by adopting a river basin approach for comprehensive planning and management.

4.15. NAMAMI GANGA PROGRAM

Accordingly, an Integrated Ganga Conservation Mission called "Namami Gange" has been proposed to be set up and a sum of Rs. 2,037 crores has been set aside for the purpose of conservation and improvement of the Ganga.

In addition a sum of Rs. 100 crores has been allocated for developments of Ghats and beautification of River Fronts at Kedarnath, Haridwar, Kanpur, Varanasi, Allahabad, Patna and Delhi in the current financial year.

Accordingly, Namami Gange approaches Ganga Rejuvenation by consolidating the existing ongoing efforts and planning for a concrete action plan for future.

The interventions at Ghats and River fronts will facilitate better citizen connect and set the tone for river centric urban planning process.

Following are proposed to be taken up under NamamiGange program:

(i) Nirmal Dhara- ensuring sustainable municipal sewage management

- Project prioritization in coordination with Ministry of Urban Development.

- Incentive for states to take up projects on Ganga Main-stem by providing an additional share of central grants for sewerage infrastructure.
- Uniform standards for both MoUD scheme and Namami Gange programme, 10 years mandatory O&M by the same service provider at par with NGRBA programme and PPP, Mandatory reuse of treated water
- Expanding coverage of sewerage infrastructure in 118 urban habitations on banks of Ganga- estimated cost by MoUD is Rs 51000 Crores

(ii) Nirmal Dhara- managing sewage from Rural Areas

- Ministry of Drinking Water and Sanitation scheme for all Ganga bank Gram Panchayts (1632) free from open defecation by 2022, at a cost of Rs 1700 Crores as central share

(iii) Nirmal Dhara- managing Industrial discharge

- Making Zero Liquid Discharge mandatory
- Rationalized water tariff to encourage reuse
- Real time water quality monitoring

(iv) AviralDhara

- Enforcing River Regulatory Zones on Ganga Banks
- Rational agricultural practices, efficient irrigation methods
- Restoration and conservation of wetlands

(v) Ensuring ecological rejuvenation by conservation of aquatic life and biodiversity

(vi) Promotion of Tourism and Shipping in a rational and sustainable manner

(vii) Knowledge Management on Ganga through Ganga Knowledge Centre leading to a Ganga University of River Sciences

NRI Ganga Fund

NRIs have been a very important contributor to the development process in India, in areas such as education, health and preservation of culture. In this context, to harness their enthusiasm to contribute towards the conservation of the river Ganga, NRI Fund for Ganga will be set up which will finance special projects. NRI Ganga Fund could be setup under the aegis of Ministry of Overseas Indian Affairs or Ministry of Finance with focus on funds sourcing and corpus management.

4.15.1. Clean Ganga fund

The main features of "Clean Ganga Fund (CGF)" are:

Considering that there is a need to increase people's participation from across the country and abroad, it is proposed to set up a "Clean Ganga Fund (CGF)" with voluntary contributions.

- CGF will have the objective of contributing to the national effort of improving the cleanliness of the river Ganga with the contributions received from the residents of the country, NRIs/ PIO and others.
- CGF will be operated through a bank account by a Trust to be headed by the finance minister. The secretariat of the Trust will be set up in Ministry of Water Resources, River Development and Ganga Rejuvenation under the Mission Director, Clean Ganga.
- Domestic donors to the fund shall be eligible for tax benefits as in the case of "Swachch Bharat Kosh". Foreign donors could get suitable tax exemptions in domestic law, wherever permissible.
- CGF will explore the possibility of setting up daughter funds in other jurisdictions/countries of high donor interest such as USA, UK, Singapore, UAE, etc. to enable tax benefits to donors in their respective jurisdictions.
- CGF will be catalytic in nature and will identify and fund specific projects which could be pilot projects, R&D projects, innovative projects or other focused projects. The Fund will define specific and measurable objectives to form the basis for planning, funding, and evaluation.

Broad activities that will be financed from the Clean Ganga Fund (CGF) Fund are:

- Activities outlined under the 'Namami Gange' programme for cleaning of river Ganga.

- Control of non-point pollution from agricultural runoff, human defecation, cattle wallowing, etc.
- Setting up of waste treatment and disposal plants along the river around the cities.
- Conservation of the biotic diversity of the river.
- Community based activities to reduce polluting human interface with the river.
- Development of public amenities including activities such as Ghat redevelopment.
- Research and Development and innovative projects.
- Research and Development projects and innovative projects for new technology and processes for cleaning the river.
- Independent oversight through intensive monitoring and real time reporting.
- Any other activity as approved by the Trust.

4.15.2. Recent Measures

- Union Environment Ministry has taken up a new strategy for conservation and rejuvenation of major river water systems. The new strategy takes into account the entire river basin, which is contributing its flow to the particular river stretch for conservation.
- The present strategy for conservation of rivers is limited only to tackling pollution load from domestic wastewater and regulation of industrial pollution. The new approach is a holistic one for rejuvenation of rivers, wherein water management and environment management are taken together for implementation to restore the lost ecology of the polluted stretches of the rivers.

Arth Ganga

- Arth Ganga signifies a sustainable development approach centered around economic activities linked to the Ganga river.
- The first component encompasses Zero Budget Natural Farming, advocating for chemical-free agriculture along both sides of the river for a distance of 10 kilometers, along with the promotion of cow dung as a natural fertilizer through the Gobardhan scheme.
- The second aspect focuses on the Monetization and Reutilization of Sludge & Wastewater. It aims to repurpose treated water for agricultural use, industrial purposes, and generating revenue for Urban Local Bodies (ULBs).
- Arth Ganga will also create opportunities for livelihood generation by establishing local markets (haats) where people can sell their regional products, including medicinal plants and Ayurvedic items.
- The fourth element emphasizes enhancing public participation by fostering greater collaboration among the various stakeholders connected with the Ganga river.
- The model strives to bolster the cultural heritage and tourism in the Ganga and its surroundings. This will be achieved through activities such as boat tourism, adventure sports, and the organization of yoga events.
- The model aims to promote institutional development by empowering local administrations to enhance water governance practices.

Do you know?

The Union Ministry of Ganga Rejuvenation has entrusted a pilot project to the Wildlife Institute of India (WII) to work towards the restoration of select aquatic species that thrive in the Ganga. The three year project will cost Rs. 25 crore and a Ganga Aqualife Conservation Monitoring Centre will also be set up at the WII as part of it.

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CHAPTER - 5

ENVIRONMENTAL POLLUTION

Pollution is defined as 'an addition or excessive addition of certain materials to the physical environment (water, air and lands), making it less fit or unfit for life'.

5.1. POLLUTANTS

- Pollutants are the materials or factors, which cause adverse effect on the natural quality of any component of the environment.
- For example, smoke from industries and automobiles, chemicals from factories, radioactive substances from nuclear plants, sewage of houses and discarded household articles are the common pollutants.

5.1.1. Classifications

(i) According to the form in which they persist after release into the environment.

- Primary pollutants: These persist in the form in which they are added to the environment e.g. DDT, plastic.
- Secondary Pollutants: These are formed by interaction among the primary pollutants.
- For example, peroxyacetyl nitrate (PAN) is formed by the interaction of nitrogen oxides and hydrocarbons.

(ii) According to their existence in nature.

- Quantitative Pollutants: These occur in nature and become pollutant when their concentration reaches beyond a threshold level. E.g. carbon dioxide, nitrogen oxide.
- Qualitative Pollutants: These do not occur in nature and are man-made. E.g. fungicides, herbicides, DDT etc.

(iii) According to their nature of disposal.

- Biodegradable Pollutants: Waste products, which are degraded by microbial action. E.g. sewage.
- Non-biodegradable Pollutants: Pollutants, which are not decomposed by microbial action. E.g. plastics, glass, DDT, salts of heavy metals, radioactive substances etc.,)

(iv) According to origin

- Natural
- Anthropogenic

5.1.2. Causes of pollution

- Uncontrolled growth in human population
- Rapid industrialization
- Urbanization
- Uncontrolled exploitation of nature.
- Forest fires, radioactivity, volcanic eruptions, strong winds etc.,

5.2. AIR POLLUTION

- Air pollution is aggravated because of four developments: increasing traffic, growing cities, rapid economic development, and industrialization.
- 'The presence in the atmosphere of one or more contaminants in such quality and for such duration as it is injurious, or tends to be injurious,

to human health or welfare, animal or plant life.'

- It is the contamination of air by the discharge of harmful substances.
- Air pollution can cause health problems, damage the environment, property and climate change.

5.2.1. Major air pollutants and their sources

Carbon monoxide (CO)

- It is a colourless, odourless gas that is produced by the incomplete burning of carbon-based fuels including petrol, diesel, and wood.
- It is also produced from the combustion of natural and synthetic products such as cigarettes.
- It lowers the amount of oxygen that enters our blood.
- It can slow our reflexes and make us confused and sleepy.

Carbon dioxide (CO2)

- It is the principle greenhouse gas emitted as a result of human activities such as the burning of coal, oil, and natural gases.

Chloroflorocarbons (CFC)

- These are gases that are released mainly from air-conditioning systems and refrigeration.
- When released into the air, CFCs rise to the stratosphere, where they come in contact with few other gases, which lead to a reduction of the ozone layer that protects the earth from the harmful ultraviolet rays of the sun.

Lead

- It is present in petrol, diesel, lead batteries, paints, hair dye products, etc. Lead affects children in particular.
- It can cause nervous system damage and digestive problems and, in some cases, cause cancer.

Ozone

- It occurs naturally in the upper layers of the atmosphere.
- This important gas shields the earth from the harmful ultraviolet rays of the sun.
- However, at the ground level, it is a pollutant with highly toxic effects.
- Vehicles and industries are the major source of ground-level ozone emissions.
- Ozone makes our eyes itch, burn, and water. It lowers our resistance to cold and pneumonia.
- Nitrogen oxide (Nox)
- It causes smog and acid rain. It is produced from burning fuels including petrol, diesel, and coal.
- Nitrogen oxide can make children susceptible to respiratory diseases in winters.

Suspended particulate matter (SPM)

- It consists of solids in the air in the form of smoke, dust, and vapour that can remain suspended for extended periods and is also the main source of haze which reduces visibility.
- The finer of these particles, when breathed in can lodge in our lungs and cause lung damage and respiratory problems.

Sulphur dioxide (SO2)

- It is a gas produced from burning coal, mainly in thermal power plants.
- Some industrial processes, such as production of paper and smelting of metals, produce sulphur dioxide.
- It is a major contributor to smog and acid rain. Sulfur dioxide can lead to lung diseases.

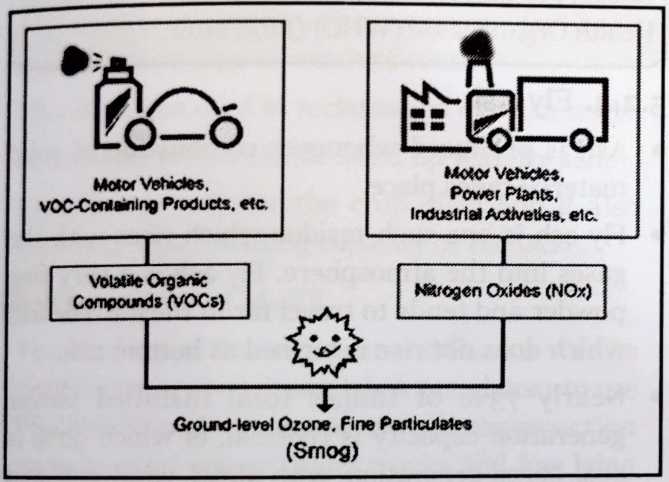
5.2.2. Smog

- The term smog was first used (1905) by Dr H A Des Voeux
- Smog has been coined from a combination of the words fog and smoke. Smog is a condition of fog that had soot or smoke in it.

The Formation of Smog

- Photochemical smog (smog) is a term used to describe air pollution that is a result of the interaction of sunlight with certain chemicals in the atmosphere.

- One of the primary components of photochemical smog is ozone.
- While ozone in the stratosphere protects earth from harmful UV radiation, ozone on the ground is hazardous to human health.
- Ground-level ozone is formed when vehicle emissions containing nitrogen oxides (primarily from vehicle exhaust) and volatile organic compounds (from paints, solvents, printing inks, petroleum products, vehicles, etc.) interact in the presence of sunlight.


Motor Vehicles, VOC-Containing Products, etc.
Motor Vehicles, Power Plants, Industrial Activeties, etc.
Volatile Organic Compounds (VOCs)
Nitrogen Oxides (NOx)
Ground-level Ozone, Fine Particulates (Smog)

- Smog refers to hazy air that causes difficult breathing conditions. It is a combination of various gases with water vapour and dust.
- Its occurrences are often linked to heavy traffic, high temperatures, and calm winds. During the winter, wind speeds are low and cause the smoke and fog to stagnate near the ground; hence pollution levels can increase near ground level.
- Smoke particles trapped in the fog gives it a yellow/black colour and this smog often settled over cities for many days.

Ground-level ozone is formed through a complex reaction involving hydrocarbons, nitrogen oxides, and sunlight. It is formed when pollutants released from gasoline, diesel-powered vehicles and oil-based solvents react with heat and sunlight.

The effects of smog

- It hampers visibility and harms the environment.
- respiratory problems
- deaths relating to bronchial diseases.
- Heavy smog greatly decreases ultraviolet radiation.
- Heavy smog results in the decrease of natural vitamin D production leading to a rise in the cases of rickets.

5.2.3. Indoor air pollution

- It refers to the physical, chemical, and biological characteristics of air in the indoor environment within a home, or an institution or commercial facility.
- Indoor air pollution is a concern where energy efficiency improvements sometimes make houses relatively airtight, reducing ventilation and raising pollutant levels.
- Indoor air problems can be subtle and do not always produce easily recognized impacts on health.
- Different conditions are responsible for indoor air pollution in the rural areas and the urban areas.

(a) Rural

- It is the rural areas that face the greatest threat from indoor pollution, where people rely on traditional fuels such as firewood, charcoal, and cowdung for cooking and heating.
- Burning such fuels produces large amount of smoke and other air pollutants in the confined space of the home, resulting in high exposure. Women and children are the groups most vulnerable as they spend more time indoors and are exposed to the smoke.
- Although many hundreds of separate chemical agents have been identified in the smoke from biofuels, the four most serious pollutants are particulates, carbon monoxide, polycyclic organic matter, and formaldehyde.

(b) Urban

- In urban areas, exposure to indoor air pollution has increased due to a variety of reasons, such as
- construction of more tightly sealed buildings,
- reduced ventilation,
- the use of synthetic materials for building and furnishing and
- the use of chemical products, pesticides, and household care products.
- Indoor air pollution can begin within the building or drawn in from outdoors.
- Other than nitrogen dioxide, carbon monoxide, and lead, there are a number of other pollutants that affect the air quality.

Pollutants

i) Volatile organic compounds

- The main indoor sources are perfumes, hair sprays, furniture polish, glues, air fresheners, moth repellents, wood preservatives, and other products.
- Health effect - irritation of the eye, nose and throat, headaches, nausea and loss of coordination.
- long term - suspected to damage the liver and other parts of the body.

ii) Tobacco

- Smoke generates a wide range of harmful chemicals and is carcinogenic.
- Health effect - burning eyes, nose, and throat irritation to cancer, bronchitis, severe asthma, and a decrease in lung function.

iii) Biological pollutants

- It includes pollen from plants, mite, and hair from pets, fungi, parasites, and some bacteria. Most of them are allergens and can cause asthma, hay fever, and other allergic diseases.

iv) Formaldehyde

- Mainly from carpets, particle boards, and insulation foam. It causes irritation to the eyes and nose and allergies.

v) Radon

- It is a gas that is emitted naturally by the soil. Due to modern houses having poor ventilation, it is confined inside the house and causes lung cancers.

vi) Asbestos

vii) Pesticides

Do you know?

Diesel engine exhaust fumes can cause cancer in humans and it belongs to the same potentially deadly category as asbestos, arsenic and mustard gas - World Health Organization (WHO) (June, 2012).

5.2.4. Fly Ash

- Ash is produced whenever combustion of solid material takes place.
- Fly ash is one such residue which rises with the gases into the atmosphere. Fly ash is a very fine powder and tends to travel far in the air. The ash which does not rise is termed as bottom ash.
- Nearly 73% of India's total installed power generation capacity is thermal, of which 90% is coal-based generation, with diesel, wind, gas, and steam making up the rest.

Composition

1. Aluminium silicate (in large amounts)
2. Silicon dioxide (SiO2) and
3. Calcium oxide (CaO).

- Fly ash particles are oxide rich and consist of silica, alumina, oxides of iron, calcium, and magnesium and toxic heavy metals like lead, arsenic, cobalt, and copper.

How it is collected?

- Fly ash is generally captured by electrostatic precipitators or other particle filtration equipments before the flue gases reach the chimneys of coal-fired power plants.

Environmental effects?

- If fly ash is not captured and disposed off properly, it can pollute air and water considerably.

- It causes respiratory problems.
- Fly ash in the air slowly settles on leaves and crops in fields in areas near to thermal power plants and lowers the plant yield.

Advantages:

- Cement can be replaced by fly ash upto 35%, thus reducing the cost of construction, making roads, etc.
- Fly ash bricks are light in weight and offer high strength and durability.
- Fly ash is a better fill material for road embankments and in concrete roads.
- Fly ash can be used in reclamation of wastelands.
- Abandoned mines can be filled up with fly ash.
- Fly ash can increase the crop yield and it also enhances water holding capacity of the land .

Policy measures of MoEF:

- The Ministry of Environment and Forests vide its notification in 2009, has made it mandatory to use Fly Ash based products in all construction projects, road embankment works and low lying land filling works within 100 kms radius of Thermal Power Station.
- To use Fly Ash in mine filling activities within 50 kms radius of Thermal Power Stations.
- The Fly Ash Management and Utilisation Mission, directed by Mational Green tribunal would be monitoring the disposal of annual stock of unutilised fly ash and will also monitor how millions of tonnes of fly ash could be utilized in the least hazardous manner and safety measures could be taken by the power plants.
- A web portal for monitoring of fly ash generation and utilisation and a mobile based application titled "ASHTRACK" has been launched by the Government.

Fly ash notification 2021

Fly Ash Notification 2021 was issued by MoEFCC under the Environment (Protection) Act 1986.

- The notification has made provision for the enforcement, monitoring, audit and reporting of the progress of fly ash utilisation and implementation by coal thermal power plants and user agencies.
- The Notification makes the CPCB and State Pollution Control Boards (SPCB) / Pollution Control Committees (PCC) responsible for monitoring the effective implementation of the mandates.
- The Notification mandates the individual thermal power plant to upload monthly information regarding ash generation and utilisation on its web portal.
- It prohibits dumping and disposal of fly ash discharged from coal or lignite based thermal power plants on land or into water bodies and the Centre has made it mandatory for such plants to ensure 100% utilization of ash in an eco-friendly manner within 3 to 5 years and introduced for the first time a penalty regime for non-compliance based on polluter pays principle.

5.2.5. Effects of air pollution

1. Health effect

Name Of Pollutant	Sources	Health Effects
Sulphur Oxides	Thermal power plants and industries	Eye and throat irritation, cough, allergies, impairs enzyme function in respiratory system. Reduces exchange of gases from lung surface.
Nitrogen Oxides	Thermal power plant, industries and vehicles	Irritation and inflammation of lungs, breathlessness, impairs enzyme function in respiratory system and causes bronchitis and asthma.

Name Of Pollutant	Sources	Health Effects
Suspended Particulate Matter (SOM)	Vehicular emissions and burning of fossil fuels	Lung irritation reduces development of RBC and cause pulmonary malfunctioning.
Carbon Monoxide	Vehicular emissions and burning of fossil fuels	Difficulty in breathing, severe headaches, irritation to mucous membrane, unconsciousness and death
Carbon Dioxide	Burning of fossil fuels	Impairs reflexes, judgment and vision, severe headaches and heart strain.
Smog	Industries and vehicular pollution	Respiratory problems and intense irritation to the eyes.
Ozone	Automobile emissions	Breathlessness, asthma, wheezing, chest pain, emphysema and chronic bronchitis.
Chlorofluorocarbons	Refrigerators, sprays, emissions from jets	Depletion of stratospheric ozone layer, global warming.
Hydrocarbons	Burning of fossil fuels	Carcinogenic effect on lungs, kidney damage, hypertension, respiratory distress, irritation of eyes, nose and throat, asthma, bronchitis and impairs enzyme function in respiratory system.
Tobacco Smoke	Cigarettes, cigars etc.	Chronic bronchitis, asthma and lung cancer, irritation of eyes, nose and throat.
Mercury	Industries	Nervous disorders, insomnia, memory loss, excitability, irritation, tremor, gingivitis and minamata disease.
Lead	Leaded petrol emissions	Damage to brain and central nervous system, kidneys and brains, impaired intelligence and interference with development of RBCs.
Cadmium	Industries	Affects the heart
Silica dust	Silicon quarries	Silicosis affects the lungs
Cotton dust	Cotton textile factories	Byssinosis involves destruction of lung tissues, chronic cough, bronchitis and emphysema.
Asbestos dust	Asbestos mining, asbestos sheet manufacturing	Asbestosis which involves severe respiratory problems and may lead to cancer.
Radioactive pollutants	Cosmic rays, x-rays, beta rays, radon and radium	Destroy living tissues and blood cells; affect cell membrane and cell enzyme functions, leukemia, and permanent genetic changes.
Coal dust and particles	Coal mines	Black lung cancer, pulmonary fibrosis which lead to respiratory failure.

II. Effects on Vegetation

- retard photosynthesis.
- Sulphur dioxide causes chlorosis, plasmolysis, membrane damage and metabolic inhibition.
- Hydrocarbons such as ethylene cause premature leaf fall, fruit drop, shedding of floral buds, curling of petals and discoloration of sepals.
- Ozone damage chlorenchyma and thus destructs the foliage in large number of plants.

III. Effects on Animals

IV. Detoriation of materials

V. Aesthetic Loss

5.2.6. Control Measures

1. Policy measures
2. Preventive measures:

- Selection of suitable fuel (e.g.fuel with low sulphur content) and its efficient utilization
- Modifications in industrial processes and/or equipments to reduce emission.
- Selection of suitable manufacturing site and zoning. e.g. setting of industries at a distance of residential areas, installation of tall chimneys.

Control measures:

(i) destroying the pollutants by thermal or catalytic combustion

(ii) conversion of the pollutants to a less toxic form

(iii) collection of the pollutant

- Different types of air pollutants can be eliminated / minimised by following methods:

a) Control of particulate matter: Two types of devices - arresters and scrubbers are used to remove particulate pollutants from air. These are arresters and scrubbers.

i. Arresters: These are used to separate particulate matters from contaminated air.

ii. Scrubbers: These are used to clean air for both dusts and gases by passing it through a dry or wet packing material.

b) Control of Gaseous Pollutants:

The gaseous pollutants can be controlled through the techniques of Combustion, absorption and adsorption.

c) Control of Automobile Exhaust

i. use of efficient engines (e.g. multipoint fuel injection engine).

ii. Catalytic converter filters in the vehicles can convert nitrogen oxide to nitrogen and reduce the potential hazards of NOx.

iii. use of good quality automobile fuels

iv. use of lead free petrol.

v. Use of compressed natural gas (CNG).

5.2.7. Government Initiatives

(a) National Air Quality Monitoring Programme

- In India, the Central Pollution Control Board (CPCB) has been executing a nationwide programme of ambient air quality monitoring known as National Air Quality Monitoring Programme (NAMP).
- The National Air Quality Monitoring Programme (NAMP) is undertaken in India

(i) to determine status and trends of ambient air quality;

(ii) to ascertain the compliance of NAAQS;

(iii) to identify non-attainment cities;

(iv) to understand the natural process of cleaning in the atmosphere; and

(v) to undertake preventive and corrective measures.

- Annual average concentration of SOx levels are within the prescribed National Ambient Air Quality Standards (NAAQS).
- This reduction from earlier levels is due to various measures taken, including the use of CNG in public transport in Delhi, the reduction of sulphur in diesel and use of LPG instead of coal as a domestic fuel.
- A mixed trend is observed in NO2 levels due to various measures taken for vehicular pollution control, such as stricter vehicular emission norms being partially offset by increased NOx levels due to the use of CNG in urban transport.

- Total suspended particulates, however, are still a matter of concern in several urban and semi urban areas.

First Functional Smog Tower of India, situated at Anand Vihar in New Delhi is of downdraft type, i.e. polluted air comes in from the top of the tower and clean air comes out of the bottom is intended for localised reduction in air pollution (Particulate Matter). The filtration system used in the tower has been designed by University of Minnesota with an expected efficiency of 90%.

(b) National Ambient Air Quality Standards (NAAQS)

- National Ambient Air Quality Standards (NAAQS) were notified in the year 1982, duly revised in 1994 based on health criteria and land uses.
- The NAAQS have been revisited and revised in November 2009 for 12 pollutants, which include

1. sulphur dioxide (SO_2),
2. nitrogen dioxide (NO_2),
3. particulate matter having size less than 10 micron (PM_{10}),
4. particulate matter having size less than 2.5 micron ($PM_{2.5}$),
5. ozone,
6. lead,
7. carbon monoxide (CO),
8. arsenic,
9. nickel,
10. benzene,
11. ammonia, and
12. benzopyrene.

(c) National Air Quality Index

- National Air Quality Index was launched by the Prime Minister in April, 2015 starting with 14 cities to disseminate air quality information. The AQI has six categories of air quality, viz Good, Satisfactory, Moderately Polluted, Poor, Very Poor and Severe with distinct colour scheme. Each of these categories is associated with likely health impacts. AQI considers eight pollutants (PM_{10}, $PM_{2.5}$, NO_2, SO_2, CO, O_3, NH_3 and Pb) for which (up to 24-hourly averaging period) National Ambient Air Quality Standards are prescribed.

(d) National Clean Air Programme (NCAP)

- The NCAP will be a mid-term, five-year action plan launched in 2019. However, the studies indicate that significant outcome in terms of air pollution initiatives are visible only in the long-term, and hence the programme may be further extended to a longer time horizon after a mid-term review of the outcomes.
- Objective-Comprehensive mitigation actions for prevention, control and abatement of air pollution besides augmenting the air quality monitoring network across the country and strengthening the awareness and capacity building activities.
- Target - The tentative national level target of 20%-30% reduction of PM 2.5 and PM 10 concentration by 2024 is proposed under the NCAP taking 2017 as the base year in 132 non attainment cities in 25 states. In September 2022, the Centre set a new target of a 40% reduction in particulate matter concentration by 2026.
- The approach for NCAP includes collaborative, multi- scale and cross-sectoral coordination between the relevant central ministries, state governments and local bodies and will partner with multilateral and bilateral international organizations, and philanthropic foundations and leading technical institutions to achieve its outcomes.

Do you know?

India has the worst air pollution in the entire world, according to a study released by World Economic Forum. Of 132 countries, India ranks dead last in the 'Air (effects on human health)' ranking.

5.2.8. Air Pollution in India

- India's air pollution, ranked among the worst in the world is adversely impacting the lifespan of its citizens, reducing most Indian lives by over three years - WHO.
- Over half of India's population – 700 million people – live in areas where fine particulate matter pollution is above India's standards for what is considered safe - 'Economic & Political Weekly'
- Of the world's top 20 polluted cities, 13 are in India. Air pollution slashes life expectancy by 3.2 years for the 700 million Indians who live in cities.
- 2014 global analysis of how nations tackle environmental challenges has ranked India 155 among 177 nations and labelled the country's air quality among the worst in the world.
- India is placed as the "bottom performer" on several indicators such as environmental health impact, air quality, water and sanitation and india's environment health severly lags behind the BRICS nations - Environmental Performance Index 2014.
- The Ganga and Yamuna are ranked among the world's 10 most polluted rivers.
- Despite the directives of the National Green Tribunal, civic agencies continue to allow concretisation in green belts. Booming real estate and demand for housing units is leading to change of land use and shrinkage of natural conservation zones such as forests, water bodies, wastelands, sanctuaries, groundwater rechargeable areas.
- Mindless concretisation of ground and green belts and booming real estate has led to heat island effect - short-wave radiations emanate from concrete surfaces at night time. Concretisation prevents ground water recharge thus depleting green cover. Tall buildings also block winds thereby reducing their cooling effect. Excessive concretisation also leads to weakening of trees.
- The environmental crisis in India is many-sided and multi-faceted which has to be addressed on different fronts and by a variety of different actors. We need to harness scientific and social-scientific expertise to develop and promote eco-friendly technologies in construction, energy, water management, industrial production and transportation. Scientific innovation needs to be complemented by legislative change as well as by changes in social behaviour.

5.2.9. Measures to control/ mitigate Delhi Air pollution

The city needs an implementation strategy to

- Reduce traffic and vehicles,
- Cut dieselization,
- Scale up integrated public transport,
- Facilitate walking and cycling,
- Tax polluting modes,
- Decide to implement Bharat Stage IV full fledgedly
- Put controls on other pollution sources.
- Implement odd-even policy and other such policies.

5.2.10. Bharat Stage norms

Bharat Stage Emission Standards, often referred to as BS norms, are government-set regulations aimed at controlling the release of air pollutants from various motor vehicles, including motorcycles, cars, and trucks. The responsibility for implementing these standards lies with the Central Pollution Control Board (CPCB), operating under the purview of the Ministry of Environment, Forest and Climate Change (MoEF&CC).

Following a Supreme Court ruling, the sale and registration of motor vehicles compliant with BS-IV (Bharat Standard IV) emissions standards have been prohibited in India. Instead, the country is transitioning to the more stringent BS-VI (Bharat Standard VI) emission norms, which were scheduled for implementation in 2020. Bharat stage emission norms in India are closely aligned with European emission standards.

BS VI norms

As of April 1, 2020, the current emission standard in India mandates that all newly manufactured, sold, and registered cars in the country must adhere to the BS-VI norms.

- BS-VI engines emit particulate matter (PM 2.5) within a range of 20 to 40 micrograms per cubic meter.
- The amount of sulfur released into the atmosphere by BS-VI-compliant engines has been significantly reduced, decreasing from 50 parts per million (ppm) to just 10 ppm.
- For diesel engines, there is a 70% reduction in nitrogen oxide emissions, while petrol engines see a 25% reduction.
- The implementation of these standards leads to reduced emissions resulting from incomplete fuel combustion due to improved fuel combustion.
- Car manufacturers are required to install three new types of equipment in vehicles to lower emissions:
    - Diesel Particulate Filter (DPF)
    - Selective Catalytic Reduction (SCR) system
    - Lean NOx trap (LNT)
- India is introducing Real Driving Emission (RDE) testing for the first time to measure a vehicle's emissions under actual driving conditions.
- Additionally, Onboard Diagnostics (OD) has been made mandatory for all automobiles.

5.2.11. Commission for Air Quality Management (CAQM)

- Commission for Air Quality Management (CAQM) in NCR and adjoining areas has set up a Decision Support System (DSS) having a web, GIS and multi-model based operational and planning decision support tool.
- This tool will help immensely in capturing the static and dynamic features of the emissions from various sources.
- It will have an integrated framework to handle both primary and secondary pollutants using chemical transport model.
- The system will also be able to handle the source specific interventions with the framework to estimate benefits of interventions and will focus on presenting the best results in a comprehensive user friendly and simple format for different users.
- Upon identification of feasible interventions, the artificial intelligence based expert system which has a hierarchical data base of simulated scenarios, potentially assessing the impact of the identified feasible intervention would be implemented by the regulatory organization such as CPCB and state PCBs.
- The on-field implementation is monitored by credible citizen watch groups and professional NGOs independently.
- Finally, air quality data collected in the vicinity of the area where intervention is implemented will be analysed to understand the real-world benefits of such intervention.

Do you know?

Ammonical Nitrogen pollution in River Yamuna has become a recurring issue. It has been caused by untreated industrial waste water, commercial fertilizers and affects river ecology and habitat.

5.3. ENVIRONMENT (PROTECTION) ACT, 1986

- As compared to all other previous laws on environment protection, the Environment (Protection) Act, 1986 is a more effective and bold measure to fight the problem of pollution.
- The genesis of the Environmental (Protection) Act, 1986, thus, is in Article 48A (Directive Principles of State Policy) and Article 51A (g) (Fundamental Duties) of the Indian Constitution.
- The Act empowers the Central Government to take all appropriate measures to prevent and control

pollution and to establish effective machinery for the purpose of protecting and improving the quality of the environment and protecting controlling and abating environmental pollution.

- The Central Government or any other person duly authorised is empowered to collect the samples of air, water, soil or other substances as evidence of the offences under the Environment (Protection) Act, 1986.
- The Act prescribes a special procedure for handling hazardous substances and the concerned person has to handle the hazardous substances according to the procedure of the Act.
- The Environment (Protection) Act, 1986 has relaxed the rule of "Locus Standi" and because of such relaxation even a common citizen can approach the Court provided he has given a notice of sixty days of the alleged offence and his intention to make a complaint to the Central Government or any other competent authority.
- This Act also empowers and authorises the Central Government to issue directions for the operation or process, prohibition, closure, or regulation of any industry. The Central Government is also authorised to stop, regulate the supply of electricity or water or any other service directly without obtaining the order of the Court in this regard.
- The Act consists of and deals with more stringent penal provisions. The minimum penalty for contravention or violation of any provision of the law is an imprisonment for a term which may extend to five years or fine up to one lakh rupees, or both. The Act also provides for the further penalty if the failure or contravention continues after the date of conviction. It is Rs. 5000/- per day. If the failure of contravention continues beyond the period of one year, then the offender is punished with imprisonment for a term which may extend to seven years.
- The Environment (Protection) Act, 1986 grants immunity to the officers of the Government for any act done under the provisions of this Act or under the powers vested in them or functions assigned to them under this Act.
- The Act debars the Civil Courts from having any jurisdiction to entertain any suit or proceeding in respect of an action, direction, order issued by Central Government or other statutory authority under this Act.
- Under the Act, there will be supremacy of provision. In other words, the provisions of this Act and the rules or orders made under this Act shall have effect and supremacy over anything inconsistent contained in any enactment other than this Act.

Environment protection act amendment 2022

- The clause allowing for imprisonment will be replaced with a requirement to pay fines instead.
- The proposed fines, as an alternative to imprisonment, are significantly higher, ranging from 5 lakh to 5 crore rupees in cases of contraventions of the Act.
- However, for severe violations resulting in grievous injury or loss of life, the offenders will be subject to the provisions of the Indian Penal Code, 1860, along with Section 24 of the EP Act.
- This elimination of prison terms also applies to the Air Act, which is the primary legislation addressing air pollution, and the Water Act, which deals with violations related to water bodies.
- An "adjudication officer" will be appointed to determine penalties in cases of environmental violations, such as failing to submit reports or provide requested information.
- The funds collected as penalties will be directed to an "Environmental Protection Fund."

5.4. WATER POLLUTION

- 'Addition of certain substances to the water such as organic, inorganic, biological, radiological, heat, which degrades the quality of water so that it becomes unfit for use'. Water pollution is not only confined to surface water, but it has also spread to ground water, sea and ocean.

5.4.1. Sources

Types of sources

1. Point Sources

- It is directly attributable to one influence. Here pollutant travels directly from source to water. Point sources are easy to regulate.

2. Diffuse or non-point source.

- It is from various ill defined and diffuse sources.
- They vary spatially and temporally and are difficult to regulate.
- The main sources of water pollution are as follows:

1) Community waste water: Include discharges from houses, commercial and industrial establishments connected to public sewerage system. The sewage contains human and animal excreta, food residues, cleaning agents, detergents and other wastes.

Type of Industry	Inorganic pollutants	Organic pollutant
Mining	Mine Wastes: Chlorides, various metals, ferrous sulphate, sulphuric acid, hydrogen sulphide, ferric hydroxide, surface wash offs, suspended solids, chlorides and heavy metals.	
Iron and Steel	Suspended solids, iron cyanide, thiocyanate, sulphides, oxides of copper, chromium, cadmium, and mercury.	Oil, phenol and neptha
Chemical Plants	Various acids and alkalies, chlorides, sulphates, nitrates of metals, phosphorus, fluorine, silica and suspended particles.	Aromatic compounds solvents, organic acids, nitro compound dyes, etc.
Pharmaceutical	-	Proteins, carbohydrates, organic solvent intermediate products, drugs and antibiotics
Soap and Detergent	Tertiary ammonium compounds alkalies	Flats and fatty acids, glycerol, polyphosphates, sulphonated hydrocarbons.
Food processing	-	Highly putrescible organic matter and pathogens
Paper and Pulp	Sulphides, bleaching liquors.	Cellulose fibres, bark, woods sugars organic acids.

Putrescibility is the process of decomposition of organic matter present in water by microorganisms using oxygen.

2) Industrial Wastes: The industries discharge several inorganic and organic pollutants, which may prove highly toxic to the living beings.

3) Agricultural sources:

- Fertilizers contain major plant nutrients such as nitrogen, phosphorus and potassium.
- Excess fertilizers may reach the ground water by leaching or may be mixed with surface water of rivers, lakes and ponds by runoff and drainage.
- Pesticides include insecticides, fungicides, herbicides, nematicides, rodenticides and soil fumigants.
- They contain a wide range of chemicals such as chlorinated hydrocarbons, organophosphates, metallic salts, carbonates, thiocarbonates, derivatives of acetic acid etc. Many of the pesticides are non-degradable and their residues have long life.

- The animal excreta such as dung, wastes from poultry farms, piggeries and slaughter houses etc. reach the water though run off and surface leaching during rainy season.

4) Thermal Pollution:

- The main sources are the thermal and nuclear power plants. The power plants use water as coolant and release hot waters to the original source. Sudden rise in temperature kills fishes and other aquatic animals.

5) Underground water pollution:

- In India at many places, the ground water is threatened with contamination due to seepage from industrial and municipal wastes and effluents, sewage channels and agricultural runoff.

6) Marine pollution:

- Oceans are the ultimate sink of all natural and manmade pollutants. Rivers discharge their pollutants into the sea. The sewerage and garbage of coastal cities are also dumped into the sea. The other sources of oceanic pollution are navigational discharge of oil, grease, detergents, sewage, garbage and radioactive wastes, off shore oil mining, oil spills.

Oil Spills

- Oil spills is one of the most dangerous of all water pollutants.
- Oil spills from tankers at sea or leaks from underground storage tanks on land are very difficult to control as oil tends to spread very fast, affecting a large area in a very short time.
- On land crude is transported through pipelines or tankers which can get damaged and spew out crude oil over the land, thereby contaminating it.
- Since crude oil is lighter than water, it floats on the surface and poses the threat of swift-spreading fire.
- Oil spills at sea decrease the oxygen level in the water and cause harm to the organisms.
- Oil spills are also a source of air and groundwater pollution.

Do you know?

The skies over North India are seasonally filled with a thick soup of aerosol particles all along the southern edge of the Himalayas, Bangladesh and the Bay of Bengal.- NASA research findings.

5.4.2. Effects of Water Pollution

1. Effects on aquatic ecosystem:

i) Polluted water reduces Dissolved Oxygen (DO) content, thereby, eliminates sensitive organisms like plankton, molluscs and fish etc.

However a few tolerant species like Tubifex (annelid worm) and some insect larvae may survive in highly polluted water with low DO content. Such species are recognised as indicator species for polluted water.

ii) Biocides, polychlorinated biphenyls (PCBs) and heavy metals directly eliminate sensitive aquatic organisms.

iii) Hot waters discharged from industries, when added to water bodies, lowers its DO content.

Do you know?

The G20 Dialogue on Water is a platform to share sustainable and resilient water management practices. First G20 Dialogue on Water was held in Saudi Arabia, 2020

2. Effects on human health:

- The polluted water usually contains pathogens like virus, bacteria, parasitic protozoa and worms, therefore, it is a source of water borne diseases like jaundice, cholera, typhoid, amoebiasis etc.

DO , BOD, COD

- Presence of organic and inorganic wastes in water decreases the dissolved Oxygen (DO) content of the water. Water having DO content below 8.0 mg L-1 may be considered as contaminated. Water having DO content below. 4.0 mg L-1 is considered to be highly polluted. DO content of water is important for the survival of aquatic organisms. A number of factors like surface turbulence, photosynthetic activity, O2 consumption by organisms and decomposition of organic matter are the factors which determine the amount of DO present in water.
- The higher amounts of waste increases the rates of decomposition and O2 consumption, thereby decreases the DO content of water. The demand for O2 is directly related to increasing input of organic wastes and is empressed as biological oxygen demand (BOD) of water.
- Water pollution by organic wastes is measured in terms of Biochemical Oxygen Demand (BOD). BOD is the amount of dissolved oxygen needed by bacteria in decomposing the organic wastes present in water. It is expressed in milligrams of oxygen per litre of water.
- The higher value of BOD indicates low DO content of water. Since BOD is limited to biodegradable materials only. Therefore, it is not a reliable method of measuring pollution load in water.
- Chemical oxygen demand (COD) is a slightly better mode used to measure pollution load in water. It is the measure of oxygen equivalent of the requirement of oxidation of total organic matter (i.e. biodegradable and non-biodegradable) present in water.

- Mercury compounds in waste water are converted by bacterial action into extremely toxic methyl mercury, which can cause numbness of limbs, lips and tongue, deafness, blurring of vision and mental derangement.

A cripling deformity called Minamata disease due to consumption of fish captured from mercury contaminated Minamata Bay in Japan was detected in 1952.

- Water contaminated with cadmium can cause itai itai disease also called ouch-ouch disease (a painful disease of bones and joints) and cancer of lungs and liver.
- The compounds of lead cause anaemia, headache, loss of muscle power and bluish line around the gum.

3. Hazards of ground water pollution:

i. Presence of excess nitrate in drinking water is dangerous for human health and may be fatal for infants.

- Excess nitrate in drinking water reacts with hemoglobin to form non-functional methaemoglobin, and impairs oxygen transport. This condition is called methaemoglobinemia or blue baby syndrome.

ii. Excess fluoride in drinking water causes neuromuscular disorders, gastro-intestinal problems, teeth deformity, hardening of bones and stiff and painful joints (skeletal fluorosis).

- High concentration of fluoride ions is present in drinking water in 13 states of India. The maximum level of fluoride, which the human body can tolerate is 1.5 parts per million (mg/1 of water). Long term ingestion of fluoride ions causes fluorosis.

iii. Over exploitation of ground water may lead to leaching of arsenic from soil and rock sources and contaminate ground water. Chronic exposure to arsenic causes black foot disease. It also causes diarrhoea, peripheral neuritis, hyperkerotosis and also lung and skin cancer.

- Arsenic contamination is a serious problem (in tube well dug areas) in the Ganges Delta, west bengal causing serious arsenic poisoning to large numbers of people. A 2007 study found that over 137 million people in more than 70 countries are probably affected by arsenic poisoning of drinking water.

4. Biological Magnification
5. Eutrophicaiton

5.4.3. Control Measures

1) Riparian buffers
2) Treatment of sewage water and the industrial effluents should be done before releasing it into water bodies.
3) Hot water should be cooled before release from the power plants
4) Domestic cleaning in tanks, streams and rivers, which supply drinking water, should be prohibited.
5) Excessive use of fertilizers and pesticides should be avoided.
6) Organic farming and efficient use of animal residues as fertilizers.
7) Water hyacinth (an aquatic weed) can purify water by taking some toxic materials and a number of heavy metals from water.
8) Oil spills in water can be cleaned with the help of bregoli - a by-product of paper industry resembling saw dust, oil zapper, micro-organisms.

The steps taken by the Government to address the issues of water pollution include the following:-

i. Preparation of action plan for sewage management and restoration of water quality in aquatic resources by State Governments;
ii. Installation of Online Effluent Monitoring System to check the discharge of effluent directly into the rivers and water bodies;
iii. Setting up of monitoring network for assessment of water quality;
iv. Action to comply with effluent standards is taken by SPCBs / PCCs to improve the water quality of the rivers;
v. Financial assistance for installation of Common Effluent Treatment Plants for cluster of Small Scale Industrial units;
vi. Issuance of directions for implementation of Zero Liquid Discharge;
vii. Issuance of directions under Section 5 of Environment (Protection) Act, 1986 to industries and under Section 18(1)(b) of Water (Prevention and Control of Pollution) Act, 1974;
viii. Implementation of National Lake Conservation Plan (NLCP) and National Wetland Conservation Programme (NWCP) for conservation and management of identified lakes and wetlands in the country which have been merged in February, 2013 into an integrated scheme of National Plan for Conservation of Aquatic Eco-systems (NPCA) to undertake various conservation activities including interception, diversion and treatment of waste water, pollution abatement, lake beautification, biodiversity conservation, education and awareness creation, community participation etc.

5.5. THERMAL POLLUTION

Thermal pollution is the rise or fall in the temperature of a natural aquatic environment caused by human influence. This has become an increasing and the most current pollution, owing to the increasing call of globalization everywhere.

Thermal pollution is caused by either dumping hot water from factories and power plants or removing trees and vegetation that shade streams, permitting sunlight to raise the temperature of these waters, release of cold water which lowers the temperature. Like other forms of water pollution, thermal pollution is widespread, affecting many lakes and vast numbers of streams and rivers in various parts of the world.

5.5.1. Major sources

- power plants creating electricity from fossil fuel
- water as a cooling agent in industrial facilities

- deforestation of the shoreline
- soil erosion

5.5.2. Ecological Effects – Warm Water

The change in temperature impacts organisms by

(a) decreasing oxygen supply, and

(b) affecting ecosystem composition.

Warm water contains less oxygen. Elevated temperature typically decreases the level of dissolved oxygen (DO) in water. So there is decrease in rate of decomposition of organic matter. Green algae are replaced by less desirable blue green algae. Many animals fail to multiply.

It also increases the metabolic rate of aquatic animals results in consumption of more food in a shorter time than if their environment were not changed. An increased metabolic rate may result in food source shortages, causing a sharp decrease in a population.

Changes in the environment may also result in a migration of organisms to another, more suitable environment and to in-migration of fishes that normally only live in warmer waters elsewhere. This leads to competition for fewer resources; the more adapted organisms moving in may have an advantage over organisms that are not used to the warmer temperature. As a result one has the problem of compromising food chains of the old and new environments. Biodiversity can be decreased as a result.

Temperature changes of even one to two degrees Celsius can cause significant changes in organism metabolism and other adverse cellular biology effects. Principal adverse changes can include rendering cell walls less permeable to necessary osmosis, coagulation of cell proteins, and alteration of enzyme metabolism. These cellular level effects can adversely affect mortality and reproduction.

Primary producers are affected by warm water because higher water temperature increases plant growth rates, resulting in a shorter life span and species overpopulation. This can cause an algae bloom which reduces the oxygen levels in the water. The higher plant density results in reduced light intensity, decreases photosynthesis and leads to an increased plant respiration rate. This is similar to the eutrophication.

A large increase in temperature can lead to the denaturing of life-supporting enzymes by breaking down hydrogen- and disulphide bonds within the quaternary structure of the enzymes. Decreased enzyme activity in aquatic organisms can cause problems such as the inability to break down lipids, which leads to malnutrition.

5.5.3. Ecological Effects – Cold Water

Thermal pollution can also be caused by the release of very cold water from the base of reservoirs into warmer rivers. This affects fish (particularly their eggs and larvae), macroinvertebrates and river productivity.

5.5.4. Control Measures

Instead of discharging heated water into lakes and streams, power plants and factories can pass the heated water through cooling towers or cooling ponds, where evaporation cools the water before it is discharged.

Alternatively, power plants can be designed or refitted to be more efficient and to produce less waste heat in the first place.

Cogeneration - process through which, the excess heat energy from generating electricity can be used in another manufacturing process that needs such energy. Where homes or other buildings are located near industrial plants, waste hot water can be used for heating–an arrangement often found in Scandinavian towns and cities, and proposed for use in China.

To prevent thermal pollution due to devegetation, the prescription is simple: do not devegetate and leave strips of trees and vegetation along streams and shorelines.

All efforts to control erosion also have the effect of keeping water clearer and, thus, cooler.

5.6. SOIL POLLUTION

- Soil is a thin layer of organic and inorganic materials that covers the Earth's rocky surface. Soil pollution is defined as the 'addition of substances to the soil, which adversely affect physical, chemical and biological properties of soil and reduces its productivity.'
- It is build-up of persistent toxic compounds, chemicals, salts, radioactive materials, or disease causing agents in soil which have adverse effects on plant growth, human and animal health.
- A soil pollutant is any factor which deteriorates the quality, texture and mineral content of the soil or which disturbs the biological balance of the organisms in the soil.

5.6.1. Causes

- Indiscriminate use of fertilizers, pesticides, insecticides and herbicides
- Dumping of large quantities of solid waste
- Deforestation and soil erosion.
- Pollution Due to Urbanisation

5.6.2. Source

i. Industrial Wastes:

- Industrial waste includes chemicals such as mercury, lead, copper, zinc, cadmium, cynides, thiocynates, chromates, acids, alkalies, organic substances etc.

ii. Pesticides:

- Pesticides are chemicals that include insecticides, fungicides, algicides, rodenticides, weedicides sprayed in order to improve productivity of agriculture, forestry and horticulture.

iii. Fertilizers and manures:

- Chemical fertilizers are added to the soil for increasing crop yield. Excessive use of chemical fertilizers reduces the population of soil borne organism and the crumb structure of the soil, productivity of the soil and increases salt content of the soil.

iv. Discarded materials:

- It includes concrete, asphalt, rungs, leather, cans, plastics, glass, discarded food, paper and carcasses.

v. Radioactive wastes:

- Radioactive elements from mining and nuclear power plants, find their way into water and then into the soil.

vi. Other pollutants:

- Many air pollutants (acid rain) and water pollutants ultimately become part of the soil and the soil also receives some toxic chemicals during weathering of certain rocks. [in box]

5.6.3. Types of Soil Pollution

I. Agricultural Soil Pollution

II. Pollution due to industrial effluents and solid wastes

III. Pollution due to urban activities

5.6.4. Effects of soil pollution on

i) Agriculture

  - Reduced soil fertility
  - Reduced nitrogen fixation
  - Increased erosion
  - Loss of soil and nutrients
  - Reduced crop yield
  - Increased salinity
  - Deposition of silt in tanks and reservoirs

ii) Health

  - Dangerous chemicals entering underground water
  - Bio magnification
  - Release of pollutant gases
  - Release of radioactive rays causing health problems

iii) Environment

- Reduced vegetation
- Ecological imbalance
- Imbalance in soil fauna and flora

iv) Urban areas

- Clogging of drains
- Inundation of areas
- Foul smell and release of gases
- Waste management problems

- Control measures
  - Reducing chemical fertilizer and pesticide use
  - Use of bio pesticides, bio fertilizers.
  - Organic farming
  - Four R's: Refuse, Reduce, Reuse, and Recycle
  - Afforestation and Reforestation
  - Solid waste treatment
  - Reduction of waste from construction areas

Four R's

1. Refuse

- Instead of buying new containers from the market, use the ones that are in the house. Refuse to buy new items though you may think they are prettier than the ones you already have.

2. Reuse

- Do not throw away the soft drink cans or the bottles; cover them with homemade paper or paint on them and use them as pencil stands or small vases.

3. Recycle

- Use shopping bags made of cloth or jute, which can be used over and over again. Segregate your waste to make sure that it is collected and taken for recycling.

4. Reduce

- Reduce the generation of unnecessary waste, e.g. carry your own shopping bag when you go to the market and put all your purchases directly into it.

5.7. NOISE POLLUTION

- Noise pollution is an unpleasant noise created by people or machines that can be annoying, distracting, intrusive, and/or physically painful.
- Noise pollution comes from sources such as "road traffic, jet planes, garbage trucks, construction equipment, manufacturing processes, leaf blowers, and boom boxes."
- Sound is measured in decibels (dB). An increase of about 10 dB is approximately double the increase in loudness.
- A person's hearing can be damaged if exposed to noise levels over 75 dB over a prolonged period of time. The World Health Organization recommends that the sound level indoors should be less than 30 dB.

5.7.1. Ambient Noise Level Monitoring

- Noise Pollution (Control and Regulation) Rules, 2000 define ambient noise levels for various areas as follows:

Category of Area/Zone	**Limits in dB(A) Leq**	
	Day Time	Night Time
	6 a.m. to 10 p.m.	10 p.m to 6 a.m
A. Industrial Area	75	70
B. Commercial Area	65	55
C. Residential Area	55	45
D. Silence Zone	50	40

- The Government of India on Mar 2011 launched a Real time Ambient Noise Monitoring Network. Under this network, in phase- I, five Remote Noise Monitoring Terminals each have been installed in different noise zones in seven metros (Delhi, Hyderabad, Kolkata, Mumbai, Bangalore, Chennai and Lucknow).
- In Phase II another 35 monitoring stations will be installed in the same seven cities. Phase III will cover installing 90 stations in 18 other cities.

- Phase-III cities are Kanpur, Pune, Surat, Ahmedabad, Nagpur, Jaipur, Indore, Bhopal, Ludhiana, Guwahati, Dehradun, Thiruvananthpuram, Bhubaneswar, Patna, Gandhinagar, Ranchi, Amritsar and Raipur.
- Silence Zone is an area comprising not less than 100 metres around hospitals, educational institutions, courts, religious places or any other area declared as such by a competent authority.

5.7.2. Impacts of noise

- Annoyance: It creates annoyance to the receptors due to sound level fluctuations. The a-periodic sound due to its irregular occurrences causes displeasure to hearing and causes annoyance.
- Physiological effects: The physiological features like breathing amplitude, blood pressure, heart-beat rate, pulse rate, blood cholesterol are affected.
- Loss of hearing: Long exposure to high sound levels cause loss of hearing. This is mostly unnoticed, but has an adverse impact on hearing function.
- Human performance: The working performance of workers/human will be affected as it distracts the concentration.
- Nervous system: It causes pain, ringing in the ears, feeling of tiredness, thereby effecting the functioning of human system.
- Sleeplessness: It affects the sleeping there by inducing people to become restless and loose concentration and presence of mind during their activities
- Damage to material: The buildings and materials may get damaged by exposure to infrasonic / ultrasonic waves and even get collapsed.

5.7.3. Control

- The techniques employed for noise control can be broadly classified as

1. Control at source

- Reducing the noise levels from domestic sectors
- Maintenance of automobiles
- Control over vibration
- Prohibition on usage of loud speakers
- Selection and maintenance of machinery

2. Control in the transmission path

- Installation of barriers
- Design of building
- Green belt development (planting of trees)

3. Using protective equipment.

- Job rotation
- Reduced Exposure time
- Hearing protection
- Documentation of noise measurements, continuous monitoring and awareness are the need of the hour.

5.8 LIGHT POLLUTION

Light pollution refers to the excessive, misdirected, or intrusive artificial lighting, primarily outdoors, that hinders the visibility of starlight in the night sky, disrupts astronomical research, disturbs ecosystems, poses health risks, and results in energy wastage.

5.8.1. Causes

- Most sources of visible light (except lasers) emit light in various directions, potentially allowing it to scatter into the atmosphere.
- In urban environments, nearly all surfaces have the ability to reflect light, causing a portion of downward-directed light to bounce back upwards, further contributing to the problem of nighttime light pollution.
- Recent research has shown that artificial light, which is not of natural origin, has been increasing the overall brightness of the night sky, known as skyglow, by approximately 9.2-10% annually between 2011 and 2022. This increase was observed at a rate of around 6.5% in Europe, 10.4% in North America, and 7.7% in other regions across the globe.

5.8.2. Light pollution in India

- According to a recent study, the lowest among G20 nations, India has approximately 19.5% of its population living in areas where skyglow is so pronounced that it obscures the view of the Milky Way and prevents human eyes from adapting to darkness.

5.8.3. Effects

- Stimulating the cone cells (which activate in a well-lit environment/during the day) in human eyes.
- Light pollution can disrupt circadian rhythms and the production of melatonin, potentially leading to sleep disorders and other health issues, including an increased risk of breast cancer.
- Poses serious threat to nocturnal animals, migrating creatures and cross light hatchery animals and their physiology.
- In 2020, a study highlighted that skyglow disrupts various aspects of insect behavior and extends the hunting time for insect predators. A 2019 study revealed that clownfish eggs fail to hatch when exposed to artificial nighttime light, resulting in the death of the offspring. During their meeting in Gandhinagar in 2020, the Convention on Migratory Species parties adopted guidelines to tackle this problem.

5.8.4. Control measures

- Only using light when and where it is required,
- Only use the necessary amount,
- Using energy-efficient bulbs, and
- Using bulbs with the right spectral power distributions.
- The "Outdoor Lighting Code" in the United Kingdom, aims to reduce light pollution by encouraging the use of lighting that is only as bright and as long as necessary for the task.

5.9. RADIO ACTIVE POLLUTION

5.9.1. Radioactive Pollution

- Radioactivity is a phenomenon of spontaneous emission of proton (a-particles), electrons (ß-particles) and gamma rays (short wave electromagnetic waves) due to disintegration of atomic nuclei of some elements. These cause radioactive pollution.

Radioactivity:

Radioactivity is a property of certain elements (radium, thorium, uranium etc.) to spontaneously emit protons (alpha particles) electrons (beta particles) and gamma rays (short-wave electromagnetic wave) by disintegration of their atomic nuclei (nuclides).

5.9.2. Types of Radiations

1. Non-ionising radiations affect only those components which absorb them and have low penetrability.
2. Ionising radiations have high penetration power and cause breakage of macro molecules.

5.9.3. Types of radiation particles

1. Alpha particles, can be blocked by a piece of paper and human skin.
2. Beta particles can penetrate through skin, while can be blocked by some pieces of glass and metal.
3. Gamma rays can penetrate easily to human skin and damage cells on its way through, reaching far, and can only be blocked by a very thick, strong, massive piece of concrete.

5.9.4. Sources

Natural

- They include cosmic rays from space and terrestrial radiations from radio-nuclides present in earth's crust such as radium-224, uranium-238, thorium-232, potassium-40, carbon-14, etc.

Man – made

- Nuclear power plants
- Nuclear weapon
- Transportation of nuclear material
- Disposal of nuclear waste
- Uranium mining
- Radiation therapy

Atomic explosion (Nuclear fallout):

- The nuclear arms use uranium-235 and plutonium-239 for fission and hydrogen or lithium as fusion material. Atomic explosions produce radioactive particles that are thrown high up into the air as huge clouds. These particles are carried to long distances by wind and gradually settle over the earth as fall out or are brought down by rain. The fall out contains radioactive substances such as strontium-90, cesium-137, iodine – 131, etc.

5.9.5. Effects

- The effects of radioactive pollutants depend upon

i. half-life

ii. energy releasing capacity

iii. rate of diffusion and

iv. rate of deposition of the pollutant.

v. Various environmental factors such as wind, temperature, rainfall also influence their effects.

Period of Radioactivity

- Each radioactive nuclide has a constant decay rate. Half-life is the time needed for half of its atoms to decay. Half-life of a radio nuclide refers to its period of radioactivity. The half-life may vary from a fraction of a second to thousands of years. The radio nuclides with long half-time are the chief source of environmental radioactive pollution.

- Radiations are of two types with regard to the mode of their action on cells.

1. Non-ionising radiations:

- They include short-wave radiations such as ultraviolet rays, which forms a part of solar radiation.
- They have low penetrating power and affect the cells and molecules which absorb them.
- They damage eyes which may be caused by reflections from coastal sand, snow (snow blindness) directly looking towards sun during eclipse.
- They injure the cells of skin and blood capillaries producing blisters and reddening called sunburns.

2. Ionising radiations.

- They include X-rays, cosmic rays and atomic radiations (radiations emitted by radioactive elements).
- Ionising radiations have high penetration power and cause breakage of macro molecules.
- The molecular damage may produce short range (immediate) or long range (delayed) effects.

i. Short range effects include burns, impaired metabolism, dead tissues and death of the organisms.

ii. Long range effects are mutations increased incidence of tumors and cancer, shortening of life-span and developmental changes.

iii. The mutated gene can persist in living organisms and may affect their progeny.

- The actively dividing cells such as Embryo, foetus, cells of skin, intestinal lining, bone marrow and gamete forming cells are more sensitive to radiations.
- Some species of animals and plants preferentially accumulate specific radioactive materials. For example, oysters deposit 65Zn, fish accumulate 55Fe, marine animals selectively deposit 90Sr.

5.9.6. Control Measures

- Prevention is the best control measure as there is no cure available for radiation damage.

i. All safety measures should be strictly enforced. Leakage of radioactive elements should be totally checked.

ii. Safe disposal of radioactive waste.

iii. Regular monitoring through frequent sampling and quantitative analysis.

iv. Safety measures against nuclear accidents.

v. Nuclear explosions and use of nuclear weapons should be completely banned.

vi. Appropriate steps should be taken to protect from occupational exposure.

5.10. SOLID WASTE

- Solid wastes are the discarded (abandoned or considered waste-like) materials. Solid waste means any garbage, refuse, sludge from a wastewater treatment plant, or air pollution control facility and other discarded materials including solid, liquid, semi-solid, or contained gaseous material, resulting from industrial, commercial, mining and agricultural operations, and from community activities. But it does not include solid or dissolved materials in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges.

5.10.1. Plastic Waste

- Plastics are considered to be one of the wonderful inventions of 20th Century. They are widely used as packing and carry bags because of cost and convenience. But plastics are now considered as environmental hazard due to the "Throw away culture".

5.10.2. Source of generation of waste plastics

- Household
- Health and medicare
- Hotel and catering
- Air/rail travel

5.10.3. Effects

- The land gets littered by plastic bag garbage and becomes ugly and unhygienic.
- Conventional plastics have been associated with reproductive problems in both humans and wildlife.
- Dioxin (highly carcinogenic and toxic) by-product of the manufacturing process is one of the chemicals believed to be passed on through breast milk to the nursing infant.
- Burning of plastics, especially PVC releases this dioxin and also furan into the atmosphere. Thus, conventional plastics, right from their manufacture to their disposal are a major problem to the environment.
- Plastic bags can also contaminate foodstuffs due to leaching of toxic dyes and transfer of pathogens.
- Careless disposal of plastic bags chokes drains, blocks the porosity of the soil and causes problems for groundwater recharge.
- Plastic disturbs the soil microbe activity. The terrestrial and aquatic animals misunderstand plastic garbage as food items, swallow them and die.
- Plastic bags deteriorates soil fertility as it forms part of manure and remains in the soil for years.
- These bags finding their way in to the city drainage system results in blockage causing inconvenience, difficult in maintenance, creates unhygienic environment resulting in health hazard and spreading of water borne diseases.
- Designing eco-friendly, biodegradable plastics are the need of the hour.

5.10.4. Types

- Solid wastes are classified depending on their source:

a) Municipal waste,

b) Hazardous waste and

c) Biomedical waste or hospital waste.

a) Municipal solid waste

- Municipal solid waste consists of household waste, construction and demolition debris, sanitation residue, and waste from streets.
- With rising urbanization and change in lifestyle and food habits, the amount of municipal solid waste has been increasing rapidly and its composition changing.
- In 1947 cities and towns in India generated an estimated 6 million tonnes of solid waste, in 1997 it was about 48 million tonnes. More than 25% of the municipal solid waste is not collected at all.
- 70% of the Indian cities lack adequate capacity to transport it and there are no sanitary landfills to dispose of the waste. The existing landfills are

neither well equipped and are not lined properly to protect against contamination of soil and groundwater.

- Over the last few years, the consumer market has grown rapidly leading to products being packed in cans, aluminium foils, plastics, and other such nonbiodegradable items that cause incalculable harm to the environment.

b) Hazardous waste

- Industrial and hospital waste is considered hazardous as they contain toxic substances. Hazardous wastes could be highly toxic to humans, animals, and plants and are corrosive, highly inflammable, or explosive.
- India generates around 7 million tonnes of hazardous wastes every year, most of which is concentrated in four states: Andhra Pradesh, Bihar, Uttar Pradesh, and Tamil Nadu.
- Household waste that can be categorized as hazardous waste include old batteries, shoe polish, paint tins, old medicines, and medicine bottles.
- In the industrial sector, the major generators of hazardous waste are the metal, chemical, paper, pesticide, dye, refining, and rubber goods industries.
- Direct exposure to chemicals in hazardous waste such as mercury and cyanide can be fatal.

c. Hospital waste

- Hospital waste is generated during the diagnosis, treatment, or immunization of human beings or animals or in research activities or in the production or testing of biologicals.
- These chemicals include formaldehyde and phenols, which are used as disinfectants, and mercury, which is used in thermometers or equipment that measure blood pressure.
- It may include wastes like soiled waste, disposables, anatomical waste, cultures, discarded medicines, chemical wastes, disposable syringes, swabs, bandages, body fluids, human excreta, etc.
- These are highly infectious and can be a serious threat to human health if not managed in a scientific and discriminate manner.
- Surveys carried out by various agencies show that the health care establishments in India are not giving due attention to their waste management.
- After the notification of the Bio-medical Waste (Handling and Management) Rules, 1998, these establishments are slowly streamlining the process of waste segregation, collection, treatment, and disposal.

5.10.5. Treatment and disposal of solid waste

i) Open dumps

- Open dumps refer to uncovered areas that are used to dump solid waste of all kinds. The waste is untreated, uncovered, and not segregated. It is the breeding ground for flies, rats, and other insects that spread disease. The rainwater run-off from these dumps contaminates nearby land and water thereby spreading disease. Treatment by open dumps is to be phased out.

ii) Landfills

- Landfills are generally located in urban areas. It is a pit that is dug in the ground. The garbage is dumped and the pit is covered with soil everyday thus preventing the breeding of flies and rats. Thus, every day, garbage is dumped and sealed. After the landfill is full, the area is covered with a thick layer of mud and the site can thereafter be developed as a parking lot or a park.
- Problems - All types of waste are dumped in landfills and when water seeps through them it gets contaminated and in turn pollutes the surrounding area. This contamination of groundwater and soil through landfills is known as leaching.

iii) Sanitary landfills

- Sanitary landfill is more hygienic and built in a methodical manner to solve the problem of leaching. These are lined with materials that are impermeable such as plastics and clay, and are also built over impermeable soil. Constructing sanitary landfills is very costly

iv) Incineration plants

- The process of burning waste in large furnaces at high temperature is known as incineration. In these plants the recyclable material is segregated and the rest of the material is burnt and ash is produced.
- Burning garbage is not a clean process as it produces tonnes of toxic ash and pollutes the air and water. A large amount of the waste that is burnt here can be recovered and recycled. In fact, at present, incineration is kept as the last resort and is used mainly for treating the infectious waste.

v) Pyrolysis

- It is a process of combustion in absence of oxygen or the material burnt under controlled atmosphere of oxygen. It is an alternative to incineration. The gas and liquid thus obtained can be used as fuels. Pyrolysis of carbonaceous wastes like firewood, coconut, palm waste, corn combs, cashew shell, rice husk paddy straw and saw dust, yields charcoal along with products like tar, methyl alcohol, acetic acid, acetone and a fuel gas.

vi) Composting

- Composting is a biological process in which micro-organisms, mainly fungi and bacteria, decompose degradable organic waste into humus like substance in the presence of oxygen.
- This finished product, which looks like soil, is high in carbon and nitrogen and is an excellent medium for growing plants.
- It increases the soil's ability to hold water and makes the soil easier to cultivate. It helps the soil retain more plant nutrients.
- It recycles the nutrients and returns them back to soil as nutrients.
- Apart from being clean, cheap, and safe, composting can significantly reduce the amount of disposable garbage.

vii) Vermiculture

- It is also known as earthworm farming. In this method, Earth worms are added to the compost. These worms break the waste and the added excreta of the worms makes the compost very rich in nutrients.

viii) Four R's

5.10.6. Waste Minimization Circles (WMC)

WMC helps Small and Medium Industrial Clusters in waste minimization in their industrial plants.

- This is assisted by the World Bank with the Ministry of Environment and Forests acting as the nodal ministry. The project is being implemented with the assistance of National Productivity Council (NPC), New Delhi.
- The initiative also aims to realize the objectives of the Policy Statement for Abatement of Pollution (1992), which states that the government should educate citizens about environmental risks, the economic and health dangers of resource degradation and the real economic cost of natural resources.
- The policy also recognizes that citizens and non-governmental organizations play a role in environmental monitoring, therefore, enabling them to supplement the regulatory system and recognizing their expertise where such exists and where their commitments and vigilance would be cost effective.
- Government Rules and Policies concerning solid waste and its types are listed below,

5.10.7. Solid Waste Management Rules, 2016

62 million tonnes of waste is generated annually in the country at present, out of which 5.6 million tonnes is plastic waste, 0.17 million tonnes is biomedical waste, hazardous waste generation is 7.90 million tonnes per annum and 15 lakh tonne is e-waste. The per capita waste generation in Indian cities ranges from 200 grams to 600 grams per day. 43 million TPA is collected, 11.9 million is treated and

31 million is dumped in landfill sites, which means that only about 75-80% of the municipal waste gets collected and only 22-28 % of this waste is processed and treated. "Waste generation will increase from 62 million tonnes to about 165 million tonnes in 2030".

Scientific disposal of solid waste through segregation, collection and treatment and disposal in an environmentally sound manner minimises the adverse impact on the environment. The local authorities are responsible for the development of infrastructure for collection, storage, segregation, transportation, processing and disposal of MSW.

The Rules are now applicable beyond Municipal areas and extend to urban agglomerations, census towns, notified industrial townships, areas under the control of Indian Railways, airports, airbase, Port and harbour, defence establishments, special economic zones, State and Central government organizations, places of pilgrims, religious & historical importance.

The source segregation of waste has been mandated to channelize the waste to wealth by recovery, reuse and recycle.

Integration of waste pickers/ ragpickers and waste dealers/ Kabadiwalas in the formal system should be done by State Governments, and Self Help Group, or any other group to be formed.

No person should throw, burn, or bury the solid waste generated by him, on streets, open public spaces outside his premises, or in the drain, or water bodies.

Generator will have to pay 'User Fee' to waste collector and for 'Spot Fine' for Littering and Non-segregation.

Time frame

i. setting up solid waste processing facilities by all local bodies having 100000 or more population: within two years

ii. census towns below 100000 population, setting up common or stand-alone sanitary landfills by or for all local bodies having 0.5 million or more population and setting up common or regional sanitary landfills by all local bodies and census towns under 0.5 million population-three years

iii. bio-remediation or capping of old and abandoned dump sites-five years.

Duties of Waste generator

Every waste generator shall segregate and store the waste generated by them in three separate streams namely bio-degradable, non-bio-degradable and domestic hazardous wastes in suitable bins and handover segregated wastes to authorized rag-pickers or waste collectors

Event organizer of more than 100 persons shall intimate the local authority, at least three working days in advance. Such person or the organizer of such event shall ensure segregation of waste at source and handing over of segregated waste to waste collector or agency as specified by local authority.

All Resident Welfare and Market Associations, Gated communities and institution with an area >5,000 sq m and all hotels and restaurant shall, withinone year from the date of notification of these rules and in partnership with the local authority by the generators as prescribed in these rules, ensure segregation of waste at source, facilitate collection of segregated waste in separate streams, handover recyclable material to either the authorized waste pickers or the authorized recyclers. The biodegradable waste shall be processed, treated and disposed of through composting or bio-methanation within the premises as far as possible. The residual waste shall be given to the waste collectors or agency as directed by the local authority.

The developers of Special Economic Zone, Industrial Estate, Industrial park to earmark at least 5% of the total area of the plot or minimum 5 plots/ sheds for recovery and recycling facility.

Duties of Ministry of Urban Development

MoUD shall formulate National Policy and Strategy on Solid Waste Management including policy on Waste to Energy in consultation with stakeholders within 6 months from the date of notification of these Rules; review of the measures taken by the States and local bodies, undertake training and capacity building of local bodies and other stakeholders; providing technical guidelines and project finance to States, UTs and local bodies on solid waste management to facilitate meeting timelines and standards

Promotion of marketing and utilization of compost

The Department of Fertilisers, Ministry of Chemicals and Fertilizers shall provide market development assistance on city compost andensure promotion of comarketing of compost with chemical fertilizers in the ratio of 3 to 4 bags: 6 to 7 bags by the fertilizer companies to the extent compost is made available for marketing to the companies.

The Ministry of Agriculture shall provide flexibility in Fertiliser Control Order for manufacturing and sale of compost , propagate utlisation of compost on farm land set up laboratories to test quality of compost produced by local authorities or their authorized agencies and issue suitable guidelines for maintaining the quality of compost and ratio of use of compost visa-a-vis chemical fertilizers while applying compost to farmland.

Promotion of waste to energy plant

Ministry of Power shall fix tariff or charges for the power generated from the Waste to Energy plants based on solid waste and ensurecompulsory purchase of power generated from such Waste to Energy plants by DISCOMs .

The Ministry of New and Renewable Energy Sources shall facilitate infrastructure creation for Waste to Energy plants and provide appropriate subsidy or incentives for such Waste to Energy plants.

All industrial units using fuel and located within 100 km from an solid waste based RDF plant shall make arrangements within six months from the date of notification of these rules to replace at least 5 % of their fuel requirement by RDF so produced.

Non recyclable waste having calorific value of 1500 K/cal/kg or more shall not be disposed of on landfills and shall only be utilized for generating energy either or through refuse derived fuel or by giving away as feed stock for preparing refuse derived fuel.

5.10.8. Hazardous Waste Manage-Ment Rules, 2016

Hazardous waste means any waste, which by reason of characteristics, such as physical, chemical, biological, reactive, toxic, flammable, explosive or corrosive, causes danger to health, or environment. It comprises the waste generated during the manufacturing processes of the commercial products such as industries involved in petroleum refining, production of pharmaceuticals, petroleum, paint, aluminium, electronic products etc. As per the information furnished by CPCB in the year 2015, the total hazardous waste generation in the country is 7.46 million metric tonnes per annum from about 44,000 industries.

Unscientific disposal of hazardous and other waste through burning or incineration leads to emission of toxic fumes comprising of Dioxins & Furans, Mercury, heavy metals, causing air pollution and associated health-related problems. Disposal in water bodies, or in municipal dumps leads to toxic releases due to leaching in land and water entailing into degradation of soil and water quality. The workers employed in such unscientific practices suffer from neurological disorders, skin diseases, genetic defects, cancer etc. Hence, there is a need for systematic management of hazardous and other waste in an environmentally sound manner by way of prevention, minimisation, re-use, recycling, recovery, utilisation including co-processing and safe disposal of waste.

Scientific disposal of hazardous waste through collection, storage, packaging, transportation and treatment, in an environmentally sound manner minimises the adverse impact on human health and on the environment. The hazardous waste can be disposed at captive treatment facility installed by the individual waste generators or at Common Hazardous Waste Treatment, Storage and Disposal Facilities (TSDFs).

For the first time, Rules have been made to distinguish between Hazardous Waste and other wastes. Other wastes include: Waste tyre, paper waste, metal scrap, used electronic items, etc. and are recognized as a resource for recycling and reuse. These resources supplement the industrial processes and reduce the load on the virgin resource of the country.

The salient features

i. The ambit of the Rules has been expanded by including 'Other Waste'.

ii. Waste Management hierarchy in the sequence of priority of prevention, minimization, reuse, recycling, recovery, co-processing; and safe disposal has been incorporated.

iii. All the forms under the rules for permission, import/export, filing of annual returns, transportation, etc. have been revised significantly, indicating the stringent approach for management of such hazardous and other wastes with simultaneous simplification of procedure.

iv. The basic necessity of infrastructure to safeguard the health and environment from waste processing industry has been prescribed as Standard Operating Procedure (SOPs), specific to waste type, which has to be complied by the stakeholders and ensured by SPCB/PCC while granting such authorisation.

v. Procedure has been simplified to merge all the approvals as a single window clearance for setting up of hazardous waste disposal facility and import of other wastes.

vi. Co-processing as preferential mechanism over disposal for use of waste as supplementary resource, or for recovery of energy has been provided.

vii. The approval process for co-processing of hazardous waste to recover energy has been streamlined and put on emission norms basis rather than on trial basis.

viii. The process of export of waste under the Rules has been streamlined by simplifying the document-based procedure and by revising the list of waste regulated for export.

ix. The basic necessity of infrastructure to safeguard the health and environment from waste processing industry has been prescribed as Standard Operating Procedure (SOPs) specific to waste type.

x. Responsibilities of State Government for environmentally sound management of hazardous and other wastes have been introduced as follows:

- Toset up/ allot industrial space or sheds for recycling, pre-processing and other utilization of hazardous or other waste
- To register the workers involved in recycling, pre-processing and other utilization activities.
- To form groups of workers to facilitate setting up such facilities;
- To undertake industrial skill development activities and ensure safety and health of workers.

xi. List of processes generating hazardous wastes has been reviewed taking into account technological evolution in the industries.

xii. State Government is authorized to prepare integrated plan for effective implementation of these provisions, and have to submit annual report to Ministry of Environment, Forest and Climate Change.

xiii. State Pollution Control Board is mandated to prepare an annual inventory of the waste generated; waste recycled, recovered, utilised including co-processed; waste re-exported and waste disposed and submit to the Central Pollution Control Board by the 30th day of September every year.

5.10.9. Hazardous and Other Wastes (Management & Trans boundary Movement) Amendment Rules, 2019

Salient features:

- Solid plastic waste has' been prohibited from import into the country including in Special Economic Zones (SEZ) and by Export Oriented Units (EOU).
- Exporters of silk waste have now been given exemption from requiring permission from the Ministry of Environment, Forest and Climate Change.
- Electrical and electronic assemblies and components manufactured in and exported from India, if found defective can now be imported back into the country, within a year of export, without obtaining permission from the Ministry of Environment, Forest and Climate Change.
- Industries which do not require consent under Water (Prevention and Control of Pollution) Act 1974 and Air (Prevention and Control of Pollution) Act 1981, are now exempted from requiring authorization also under the Hazardous and Other Wastes (Management & Transboundary Movement) Rules, 2016, provided that hazardous and other wastes generated by such industries are handed over to the authorized actual users, waste collectors or disposal facilities.

2.10.10 Construction and Demolit-Ion Waste Management Rules, 2016

The salient features are:

Applies to everyone who generates construction and demolition waste.

Duties of waste Generators

- Every waste generator shall segregate construction and demolition waste and deposit at collection centre or handover it to the authorised processing facilities
- Shall ensure that there is no littering or deposition so as to prevent obstruction to the traffic or the public or drains.
- Large generators (who generate more than 20 tons or more in one day or 300 tons per project in a month) shall submit waste management plan and get appropriate approvals from the local authority before starting construction or demolition or remodeling work,
- Large generators shall have environment management plan to address the likely environmental issues from construction, demolition, storage, transportation process and disposal / reuse of C & D Waste.
- Large generators shall segregate the waste into four streams such as concrete, soil, steel, wood and plastics, bricks and mortar.

Duties of Service providers and Contractors

- The service providers shall prepare a comprehensive waste management plan for waste generated within their jurisdiction, within six months from the date of notification of these rules,
- Shall remove all construction and demolition waste in consultation with the concerned local authority on their own or through any agency.

Timeframe for implementation

- Million plus cities (based on 2011 census of India), shall commission the processing and disposal facility within one-and-a-half years from date of final notification of these rules
- 0.5 to 1 million cities, shall commission the processing and disposal facility within two years from date of final notification of these rules
- for other cities (< 0.5 million populations), shall commission the processing and disposal facility within three years from date of final notification of these rules

Local Authority shall be responsible for proper management of construction and demolition waste within its jurisdiction including placing appropriate containers for collection of waste, removal at regular intervals, transportation to appropriate sites for processing and disposal. Procurement of materials made from construction and demolition waste shall be made mandatory to a certain percentage (say 10-

20%) in municipal and Government contracts subject to strict quality control.

2.10.11 Bio-Medical Waste Management Rules, 2016

Biomedical waste comprises human & animal anatomical waste, treatment apparatus likeneedles, syringes and other materials used in health care facilities in the process of treatment and research. This waste is generated during diagnosis, treatment or immunisation in hospitals, nursing homes, pathological laboratories, blood bank, etc. Total bio-medical waste generation in the country is 484 TPD from 1,68,869 healthcare facilities (HCF), out of which 447 TPD is treated.

The hospitals servicing 1000 patients or more per month are required to obtain authorisation and segregate biomedical waste in to 10 categories, pack five colour backs for disposal.

The quantum of waste generated in India is estimated to be 1-2 kg per bed per day in a hospital and 600 gm per day per bed in a clinic. 85% of the hospital waste is non-hazardous, 15% is infectious/hazardous. Mixing of hazardous results in to contamination and makes the entire waste hazardous. Hence there is necessity to segregate and treat. Improper disposal increases risk of infection; encourages recycling of prohibited disposables and disposed drugs; and develops resistant microorganisms

Scientific disposal of Biomedical Waste through segregation, collection and treatment in an environmentally sound manner minimises the adverse impact on health workers and on the environment.

The salient features

(a) The ambit of the rules has been expanded to include vaccination camps, blood donation camps, surgical camps or any other healthcare activity;

(b) Phase-out the use of chlorinated plastic bags, gloves and blood bags within two years;

(c) Pre-treatment of the laboratory waste, microbiological waste, blood samples and blood bags through disinfection orsterilisation on-site in the manner as prescribed by WHOor NACO;

(d) Provide training to all its health care workers and immunise all health workers regularly;

(e) Establish a Bar-Code System for bags or containers containing bio-medical waste for disposal;

(f) Report major accidents;

(g) Existing incinerators to achieve the standards for retention time in secondary chamber and Dioxin and Furans within two years;

(h) Bio-medical waste has been classified in to 4 categories instead 10 to improve the segregation of waste at source;

(i) Procedure to get authorisation simplified. Automatic authorisation for bedded hospitals. The validity of authorization synchronised with validity of consent orders for Bedded HCFs. One time Authorisation for Non-bedded HCFs;

(j) The new rules prescribe more stringent standards for incinerator to reduce the emission of pollutants in environment;

(k) Inclusion of emissions limits for Dioxin and furans;

(l) State Government to provide land for setting up common bio-medical waste treatment and disposal facility;

(m) No occupier shall establish on-site treatment and disposal facility, if a service of `common bio-medical waste treatment facility is available at a distance of seventy-five kilometer.

(n) Operator of a common bio-medical waste treatment and disposal facility to ensure the timely collection of bio-medical waste from the HCFs and assist the HCFs in conduct of training

Amendment Rules, 2018

- Phase out chlorinated plastic bags (excluding blood bags) and gloves by March 27, 2019.

- All healthcare facilities shall make available the annual report on its website within a period of two years (from 2018).
- Operators of common bio-medical waste treatment and disposal facilities shall establish barcoding and global positioning system for handling of bio-medical waste in accordance with guidelines issued by the CPCB.
- Every person having administrative control over the institution generating biomedical waste shall pre-treat it through sterilization on-site in the manner as prescribed by WHO and then sent to the Common bio-medical waste treatment facility for final disposal.

5.11. E - WASTE

- The discarded and end-of-life electronic products ranging from computers, equipment used in Information and Communication Technology (ICT), home appliances, audio and video products and all of their peripherals are popularly known as Electronic waste (E-waste).
- E-waste is not hazardous if it is stocked in safe storage or recycled by scientific methods or transported from one place to the other in parts or in totality in the formal sector. The e-waste can, however, be considered hazardous if recycled by primitive methods.

5.11.1. Source and its health effects

S.NO	PARTICULARS	SOURCE	HEALTH EFFECTS
1.	Lead	Used in glass panels and gaskets in computer monitors Solder in printed circuit boards and other Components	Lead causes damage to the central and peripheral nervous systems, blood systems, kidney and reproductive system in humans. It also effects the endocrine system, and impedes brain development among children. Lead tends to accumulate in the environment and has high acute and chronic effects on plants, animals and microorganisms.
2.	Cadmium	Occurs in SMD chip resistors, infra-red detectors, and semiconductor chips Some older cathode ray tubes contain cadmium	Toxic cadmium compounds accumulate in the human body, especially the kidneys.
3.	Mercury	It is estimated that 22 % of the yearly world consumption of mercury is used in electrical and electronic equipment Mercury is used in thermostats, sensors, relays, switches, medical equipment, lamps, mobile phones and in batteries Mercury, used in flat panel displays, will likely increase as their use replaces cathode ray tubes	Mercury can cause damage to organs including the brain and kidneys, as well as the foetus. The developing foetus is highly vulnerable to mercury exposure. When inorganic mercury spreads out in the water, it is transformed to methylated mercury which bio-accumulates in living organisms and concentrates through the food chain, particularly via fish.

4.	Hexavalent Chromium/ Chromium VI 29	Chromium VI is used as corrosion protector of untreated and galvanized steel plates and as a decorative or hardener for steel housings Plastics (including PVC): Dioxin is released when PVC is burned. The largest volume of plastics (26%) used in electronics has been PVC. PVC elements are found in cabling and computer housings. Many computer moldings are now made with the somewhat more benign ABS plastics	Chromium VI can cause damage to DNA and is extremely toxic in the environment.
5.	Brominated flame retardants (BFRs):	BFRs are used in the plastic housings of electronic equipment and in circuit boards to prevent flammability	
6.	Barium	Barium is a soft silvery-white metal that is used in computers in the front panel of a CRT, to protect users from radiation	Studies have shown that short-term exposure to barium causes brain swelling, muscle weakness, damage to the heart, liver, and spleen.
7.	Beryllium	Beryllium is commonly found on motherboards and finger clips It is used as a copper-beryllium alloy to strengthen connectors and tinyplugs while maintaining electrical conductivity	Exposure to beryllium can cause lung cancer. Beryllium also causes a skin disease that is characterised by poor wound healing and wartlike bumps. Studies have shown that people can develop beryllium disease many years following the last exposure.
8.	Toners	Found in the plastic printer cartridge containing black and color toners.	Inhalation is the primary exposure pathway, and acute exposure may lead to respiratory tract irritation. Carbon black has been classified as a class 2B carcinogen, possibly carcinogenic to humans. Reports indicate that colour toners (cyan, magenta and yellow) contain heavy metals.
9.	Phosphor and additives	Phosphor is an inorganic chemical compound that is applied as a coat on the interior of the CRT faceplate.	The phosphor coating on cathode ray tubes contains heavy metals, such as cadmium, and other rare earth metals, for example, zinc, vanadium as additives. These metals and their compounds are very toxic. This is a serious hazard posed for those who dismantle CRTs by hand.

5.11.2. E – Waste in India

- According to Indian Cellular and Electronics Association Report, 1.6 million tonnes of e-waste generation was reported in the country in 2022. No comprehensive State-wise inventorization of e-waste generation in the country has been done.
- In India, among top ten cities, Mumbai ranks first in generating e-waste followed by Delhi, Bangalore, Chennai, Kolkata, Ahmadabad, Hyderabad, Pune, Surat and Nagpur.
- The 65 cities generate more than 60% of the total generated e-waste, whereas, 10 states generate 70% of the total e-waste.
- Most of the e-waste is recycled in India in unorganized units, which engage significant number of manpower. Recovery of metals by primitive means is a most hazardous act.
- The recycling process, if not carried out properly, can cause damage to human being through inhalation of gases during recycling, contact of the skin with hazardous substances and contact during acid treatment used in recovery process.
- Proper education, awareness and most importantly alternative cost effective technology need to be provided so that better means can be provided to those who earn the livelihood from this.
- A holistic approach is needed to address the challenges faced by India in e-waste management. A suitable mechanism needs to be evolved to include small units in unorganized sector and large units in organized sector into a single value chain.

5.11.3. E-Waste Management Rules, 2016

17 lakh tonnes of E-waste is generated every year, with an annual increase of 5 per cent of generation of E-waste.

For the first time, the Rules will bring the producers under Extended Producer Responsibility (EPR), along with targets. The producers have been made responsible for collection of E-waste and for its exchange

Salient features

1. Manufacturer, dealer, refurbisher and Producer Responsibility Organization (PRO) have been introduced as additional stake holders in the rules.
2. The applicability of the rules has been extended to components, consumables, spares and parts of EEE in addition to equipment as listed in Schedule I.
3. Compact Fluorescent Lamp (CFL) and other mercury containing lamp brought under the purview of rules.
4. Collection mechanism based approach has been adopted to include collection centre, collection point, take back system etc for collection of e-waste by Producers under Extended Producer Responsibility (EPR).
5. Option has been given for setting up of PRO, e-waste exchange, e- retailer, Deposit Refund Scheme as additional channel for implementation of EPR by Producers to ensure efficient channelization of e-waste.
6. Provision for Pan India EPR Authroization by CPCB has been introduced replacing the state wise EPR authorization.
7. Collection and channelisation of e-waste in Extended Producer Responsibility - Authorisation shall be in line with the targets prescribed in Schedule III of the Rules. The phase wise Collection Target for e-waste, which can be either in number or Weight shall be 30% of the quantity of waste generation as indicated in EPR Plan during first two year of implementation of rules followed by 40%during third and fourth years, 50% during fifth and sixth years and 70% during seventh year onwards.
8. Deposit Refund Scheme has been introduced as an additional economic instrument wherein the producer charges an additional amount as a deposit at the time of sale of the electrical and electronic equipment and returns it to the consumer along with interest when the end-of life electrical and electronic equipment is returned.

9. The e-waste exchange as an option has been provided in the rules as an independent market instrument offering assistance or independent electronic systems offering services for sale and purchase of e-waste generated from end-of-life electrical and electronic equipment between agencies or organizations authorised under these rules.
10. The manufacturer is also now responsible to collect e-waste generated during the manufacture of any electrical and electronic equipment and channelise it for recycling or disposal and seek authorization from SPCB.
11. The dealer, if has been given the responsibility of collection on behalf of the producer, need to collect the e-waste by providing the consumer a box and channelize it to Producer.
12. Dealer or retailer or e-retailer shall refund the amount as per take back system or Deposit Refund Scheme of the producer to the depositor of e-waste.
13. Refurbisher need collect e-waste generated during the process of refurbishing and channelise the waste to authorised dismantler or recycler through its collection centre and seek one time authorization from SPCB.
14. The roles of the State Government has been also introduced in the Rules in order to ensure safety, health and skill development of the workers involved in the dismantling and recycling operations.
15. The transportation of e-waste shall be carried out as per the manifest system whereby the transporter shall be required to carry a document (three copies) prepared by the sender, giving the details.
16. Liability for damages caused to the environment or third party due to improper management of e-waste including provision for levying financial penalty for violation of provisions of the Rules has also been introduced.
17. Urban Local Bodies (Municipal Committee/Council/Corporation) has been assign the duty to collect and channelized the orphan products to authorized dismantler or recycler.

Amendment Rules, 2018

- The e-waste collection targets under extended producer responsibility (EPR) have been revised. The phase-wise collection targets for e-waste in weight shall be 10% of the quantity of waste generation as indicated in the EPR Plan during 2017-18, with a 10% increase every year until 2023. From 2023 onwards, the target has been made 70% of the quantity of waste generation as indicated in the EPR Plan.
- Separate e-waste collection targets have been drafted for new producers
- Under the Reduction of Hazardous Substances (RoHS) provisions, cost for sampling and testing shall be borne by the government for conducting the RoHS test. If the product does not comply with RoHS provisions, then the cost of the test will be borne by the Producers.

5.11.4. E waste management rules 2022

These rules will launch a new Extended Producer Responsibility (EPR) regime for e-waste recycling. The salient feature of new rules is as under:

- All the manufacturer, producer, refurbisher and recycler are required to register on portal developed by CPCB.
- Authorization has now been replaced by Registration through online portal and only manufacturer, producer, refurbisher and recycler require Registration.
- Producers of notified EEE, have been given annual E-Waste Recycling targets based on the generation from the previously sold EEE or based on sales of EEE as the case may be. Target may be made stable for 2 years and starting from 60% for the year 2023-2024 and 2024-25; 70% for the year 2025-26 and 2026-27 and 80% for the year 2027-28 and 2028-29 and onwards.

- Management of solar PV modules /panels/ cells added in new rules.
- The quantity recycled will be computed on the basis of end products, so as to avoid any false claim.
- Provision for generation and transaction of EPR Certificate has been introduced.
- Provisions for environment compensation and verification & audit has been introduced.
- Provision for constitution of Steering Committee to oversee the overall implementation of these rules.
- Under the E-Waste Management Rules, provision for reduction of hazardous substances in manufacturing of Electrical and Electronic Equipment (EEE) has been provided. It mandates that every producer of EEE and their components shall ensure that their products do not contain lead, mercury and other hazardous substances beyond the maximum prescribed concentration.
- The E-Waste (Management) Rules also provide for recognition and registration, skill development, monitoring and ensuring safety and health, of workers involved in dismantling and recycling of e-waste.

5.12. PLASTIC POLLUTION

The marine resource covering 70 percent of the earth's surface is a key asset in the biosphere. Of the nearly 1.5 million species known, nearly a quarter million live in the world's oceans. More importantly, nearly 50 percent of the global primary production takes place in the upper stratum of sea water. Seafood presently represents 20% of the protein in global diet.

The health of the marine food web and the fisheries resources invariably depend upon the long-term viability of the autotrophic algae (phytoplankton – primary producer) and the zooplankton (primary consumers) in the marine food pyramid.

Plastics represent the latest contaminant in the marine environment; the increased use of plastics has lead to negative environmental impacts.

Plastics pollution can interfere with the plankton species that form the foundation of the food web, and other organisms adversely affecting the delicate balance in the marine ecosystem.

5.12.1. Plastics as a Waste Material- in Marine Environment

The amount of plastic waste estimation annually introduced into the marine environment is not available. But, plastic waste is well known to result primarily from fishing-related activities, and from non-point source influx from beaches.

There are two clear differences between the fate of plastics debris in the ocean environment as opposed to on land environments.

a) The rate of UV-induced photo-oxidative degradation of plastics floating or submerged at sea is very much slower than that exposed to the same solar radiation on land.

b) Unlike on land there is no easy means of retrieval, sorting and recycling of plastic waste that enters into the ocean environment.

These two factors generally result in extended lifetimes for plastics at sea.

The plastic waste that has been introduced into the world's oceans must accumulate for the most part intact and unmineralized in the marine environment. While the fate of such plastics is not clear, it is reasonable to expect at least some of it to continue disintegrating into microparticulate debris. Recent reports even indicate an increase in their counts over the last two decades.

Impact of Microparticles

Challenging the Antarctic krill and other zooplankton with plastic beads that are about 20 microns or so in size has demonstrated that these microparticulates are readily ingested by these organisms. They appear to ingest the particles unselectively, and the ingestion rates depend on the concentration of particles in the environment.

Plastics are bio-inert and are not expected to be toxic to the animal in the conventional sense. While physical obstruction or indirect interference with physiology is always possible (as with sea birds showing satiation on ingesting plastics) the material will pass through the animal virtually unchanged.

The concern, however, is that plastics exposed to sea water tends to concentrate toxic and non-toxic organic compounds present in the sea water at low concentrations. These, including PCBs, DDT, and nonylphenols, have very high partition coefficients and are very efficiently concentrated in the plastic material.

Plastic-related distress to over 250 species has been documented worldwide. The focus has very much been on larger species in surface waters or beaches, despite the fact that 99 percent of marine species live in the benthos. The impact of negatively buoyant plastic waste (such as nylon net fragments) on benthic species has remained virtually unaddressed.

Despite years of interest on the topic little research has been carried out by the government agencies or the plastics industry to address the key issues relating to plastics in the marine environment.

5.12.2. Plastics as a Waste Material- in Land Environment

Problems with the uncollected plastic waste, include

(i) Choking of drains by plastic carry bags which may lead to unhygienic environment and water borne diseases,

(ii) Causing of illness and possible death of animals that may feed on plastics from garbage bins,

(iii) Non-biodegradable and impervious nature of plastics disposed on soil which may arrest recharge of ground water aquifers,

(iv) presence of additives and plasticizers, fillers, flame retardants and pigments used in the plastic products which have potential to cause adverse health impact and ground water pollution.

5.12.3 Plastic Waste Management Rules, 2016

15,000 tonnes of plastic waste is generated every day, out of which 9,000 tonnes is collected and processed, but 6,000 tonnes of plastic waste is not being collected.

An eco-friendly product, which is a complete substitute of the plastic in all uses, has not been found till date. In the absence of a suitable alternative, it is impractical and undesirable to impose a blanket ban on the use of plastic all over the country. The real challenge is to improve plastic waste management systems.

Salient features

1. Increase minimum thickness of plastic carry bags from 40 to 50 microns and stipulate minimum thickness of 50 micron for plastic sheets also to facilitate collection and recycle of plastic waste.
2. To promote use of plastic waste for road construction as per Indian Road Congress guidelines or energy recovery, or waste to oil etc. for gainful utilization of waste
3. Rural areas have been brought in ambit of these Rules since plastic has reached torural areas also. Responsibility for implementation of the rules is given to Gram Panchayat.
4. First time, responsibility of waste generators is being introduced. Individual and bulk generators like offices, commercial establishments, industries are to segregate the plastic waste at source, handover segregated waste, pay user fee as per bye-laws of the local bodies.
5. Plastic products are left littered after the public events (marriage functions, religious gatherings, public meetings etc) held in open spaces. First time, persons organizing such events have been made responsible for management of waste generated from these events.
6. Use of plastic sheet for packaging, wrapping the commodity except those plastic sheet's thickness, which will impair the functionality of the product are brought under the ambit of these rules. A large number of commodities are being packed/ wrapped into plastic sheets and thereafter such sheets are left for littered. Provisions have been introduced to ensure their collection and channelization to authorised recycling facilities.

7. Extended Producer Responsibility: Earlier, EPR was left to the discretion of the local bodies. First time, the producers and brand owners have been made responsible for collecting waste generated from their products. They have to approach local bodies for formulation of plan/system for the plastic waste management within the prescribed time frame.
8. SPCBs will not grant/renew registration of plastic bags, or multi-layered packaging unless the producer proposes the action plan endorsed by the concerned State Development Department.
9. Producers to keep a record of their vendors to whom they have supplied raw materials for manufacturing carry bags, plastic sheets, and multi-layered packaging. This is to curb manufacturing of these products in unorganised sector.
10. The entry points of plastic bags/plastic sheets/multi-layered packaging in to commodity supply chain are primarily the retailers and street vendors. They have been assigned the responsibility of not to provide the commodities in plastic bags/plastic sheets/multi-layered packaging which do not conform to these rules. Otherwise, they will have to pay the fine.
11. Plastic carry bag will be available only with shopkeepers/street vendors pre-registered with local bodies on payment of certain registration fee. The amount collected as registration fee by local bodies is to be used for waste management.
12. CPCB has been mandated to formulate the guidelines for thermoset plastic (plastic difficult to recycle). In the earlier Rules, there was no specific provision for such type of plastic.
13. Manufacturing and use of non-recyclable multi-layered plastic to be phased in two years.

Amendment Rules, 2018

- Phasing out of Multilayered Plastic (MLP) is now applicable to MLP, which are non-recyclable, or non-energy recoverable, or with no alternative use.
- Central registration system for the registration of the producer/importer/brand owner.
- A national registry has been prescribed for producers with a presence in more than two states, a state-level registration has been prescribed for smaller producers/brand owners operating within one or two states.
- Explicit pricing of carry bags has been omitted.

5.12.4. Plastic Waste Management Amendment Rules, 2021,

- The manufacture, import, stocking, distribution, sale and use of following single-use plastic, including polystyrene and expanded polystyrene, commodities shall be prohibited with effect from the 1st July, 2022:-

Single use plastic products of:-

  - ear buds with plastic sticks, plastic sticks for balloons, plastic flags, candy sticks, ice-cream sticks, polystyrene [Thermocol] for decoration;
  - plates, cups, glasses, cutlery such as forks, spoons, knives, straw, trays, wrapping or packing films around sweet boxes, invitation cards, and cigarette packets, plastic or PVC banners less than 100 micron, stirrers.

- In order to stop littering due to light weight plastic carry bags, with effect from September, 2021, the thickness of plastic carry bags has been increased from fifty microns to seventy five microns and to one hundred and twenty microns with effect from the December, 2022. This will also allow reuse of plastic carry due to increase in thickness.
- The plastic packaging waste, which is not covered under the phase out of identified single use plastic items, shall be collected and managed in an environmentally sustainable way through the Extended Producer Responsibility of the Producer, importer and Brand owner (PIBO).
- the Guidelines for Extended Producer Responsibility have been given legal force through Plastic Waste Management Amendment Rules, 2021 for effective implementation.

- (In the 4th United Nations Environment Assembly held in 2019, India had piloted a resolution on addressing single-use plastic products pollution, recognizing the urgent need for the global community to focus on this very important issue. The adoption of this resolution at UNEA 4 was a significant step.)

Amendment rules 2022

- Classification of Plastics:
  - Category 1: Rigid plastic packaging
  - Category 2: Flexible plastic packaging of single layer or multilayer (more than one layer with different types of plastic), plastic sheets and covers made of plastic sheet, carry bags, plastic sachet or pouches.
  - Category 3: Multi-layered plastic packaging (at least one layer of plastic and at least one layer of material other than plastic).
  - Category 4: Plastic sheet or like used for packaging as well as carry bags made of compostable plastics.
- Reuse of rigid plastic packaging material has been mandated in the guidelines to reduce the use of fresh plastic material for packaging.
- For the first time, the guidelines allow for sale and purchase of surplus extended producer responsibility certificates. This will set-up a market mechanism for plastic waste management.
- The centre has announced for establishing a centralised online portal by Central Pollution Control Board (CPCB) for the registration as well as filing of annual returns by producers, importers and brand-owners, plastic waste processors of plastic packaging waste by 31st March, 2022.
- It would act as the single point data repository with respect to orders and guidelines related to implementation of EPR for plastic packaging under Plastic Waste Management Rule, 2016.
- Environmental compensation will be levied based upon polluter pays principle, with respect to non-fulfilment of EPR targets by producers, importers and brand owners, for the purpose of protecting and improving the quality of the environment and preventing, controlling and abating environment pollution.
- A committee constituted by the CPCB under the chairmanship of CPCB chairman will recommend measures to the environment ministry for effective implementation of EPR, including amendments to Extended Producer Responsibility (EPR) guidelines.
- State Pollution Control Board (SPCBs) or Pollution Control Committees (PCCs) have been tasked to submit an annual report on EPR portal with respect to its fulfillment by producers, importers and brand-owners and plastic waste processors in the state/Union Territory to the CPCB

5.13. BIOREMEDIATION

- Bioremediation is the use of microorganisms (bacteria and fungi) to degrade the environmental contaminants into less toxic forms.
- The microorganisms may be indigenous to a contaminated area or they may be isolated from elsewhere and brought to the contaminated site.

The process of bioremediation can be monitored indirectly by measuring the Oxidation Reduction Potential or redox in soil and groundwater, together with pH, temperature, oxygen content, electron acceptor/donor concentrations, and concentration of breakdown products (e.g. carbon dioxide)

5.13.1. Bioremediation Strategies

(a) In situ bioremediation techniques

- It involves treatment of the contaminated material at the site.
  - Bioventing – supply of air and nutrients through wells to contaminated soil to stimulate the growth of indigenous bacteria. It is used for simple hydrocarbons and can be used where the contamination is deep under the surface.

- Biosparging - Injection of air under pressure below the water table to increase groundwater oxygen concentrations and enhance the rate of biological degradation of contaminants by naturally occurring bacteria
- Bioaugmentation - Microorganisms are imported to a contaminated site to enhance degradation process.

(b) Ex situ bioremediation techniques

- Ex situ -involves the removal of the contaminated material to be treated elsewhere.
  - Landfarming - contaminated soil is excavated and spread over a prepared bed and periodically tilled [] until pollutants are degraded.The goal is to stimulate indigenous biodegradative microorganisms and facilitate their aerobic degradation of contaminants.
  - Biopiles - it is a hybrid of landfarming and composting. Essentially, engineered cells are constructed as aerated composted piles. Typically used for treatment of surface contamination with petroleum hydrocarbons.
  - Bioreactors – it involves the processing of contaminated solid material (soil, sediment, sludge) or water through an engineered containment system.
  - Composting – dealt earlier in solid waste management

Using bioremediation techniques, TERI has developed a mixture of bacteria called 'oilzapper' which degrades the pollutants of oil-contaminated sites, leaving behind no harmful residues. This technique is not only environment friendly, but also highly cost-effective.

5.13.2. Genetic engineering approaches

Phytoremediation

- Phytoremediation is use of plants to remove contaminants from soil and water .

Types

- **Phytoextraction / phytoaccumulation** is the process by which plants accumulate contaminants into the roots and above ground shoots or leaves.
- **Phytotransformation or phytodegradation** refers to the uptake of organic contaminants from soil, sediments, or water and their transformation to more stable, less toxic, less mobile form.
- **Phytostabilization** is a technique in which plants reduce the mobility and migration of contaminated soil. Leachable constituents are adsorbed and bound into the plant structure so that they form unstable mass of plant from which the contaminants will not re-enter the environment.
- **Phytodegradation or rhizodegradation** is the breakdown of contaminants through the activity existing in the rhizosphere. This activity is due to the presence of proteins and enzymes produced by the plants or by soil organisms such as bacteria, yeast, and fungi.
- **Rhizofiltration** is a water remediation technique that involves the uptake of contaminants by plant roots. Rhizofiltration is used to reduce contamination in natural wetlands and estuary areas.

The bacterium Deinococcus radiodurans has been used to de toxify toluene and ionic mercury which are released from radioactive nuclear waste.

Mycoremediation

- is a form of bioremediation in which fungi are used to decontaminate the area.

Mycofiltration

- is a similar process, using fungal mycelia to filter toxic waste and microorganisms from water in soil.

Advantages of bioremediation

- Useful for the complete destruction of a wide variety of contaminants.

- The complete destruction of target pollutants is possible.
- Less expensive.
- Environment friendly

Disadvantages of bioremediation

- Bioremediation is limited to those compounds that are biodegradable. Not all compounds are susceptible to rapid and complete degradation.
- Biological processes are often highly specific.
- It is difficult to extrapolate from bench and pilot-scale studies to full-scale field operations.
- Bioremediation often takes longer time than other treatment process.

5.14. ENVIRONMENTAL POLLUTION AND HEALTH

First

- Pollution inventory and apportionment studies that assess relative contribution of different sources are looked at in isolation and not within a coherent framework of health protection.
- What ultimately should drive policy is not just what source is emitting more but which source is likely to lead to a greater exposure to health damaging pollutants.
- Globally, studies show vehicles contribute from a quarter to close to half of the particulates in cities.

Second

- Our scientists do not say that people are exposed to much higher health damaging pollutants than what occurs in ambient conditions.
- With each breath we inhale three-four times more pollutants than the ambient air concentration.
- Exposure to vehicular fumes is highest on road and up to 500 metres from there. The majority in our cities lives in that zone.

Third

- People are exposed to a mixture of pollutants whose combined effect has serious health impact. The benefits are greater when pollution sources are regulated for multi-pollutants.
- Delhi's air is thick with particulate matter, nitrogen oxides, ozone and air toxins.
- There is merit in NGT's focus on diesel emissions which is a multi-pollutant mixture classified as a class one carcinogen for its strong link with lung cancer. Exposure to toxins should be eliminated.

Fourth

- Our air quality policies are cut off from the reported reality in the health sector.
- India is experiencing a rapid health transition, with a large and rising burden of chronic diseases, estimated to be more than half of all deaths and years lost to illness.
- Cancer, stroke, and chronic lung diseases are now major public health problems that are strongly influenced by air pollution.

5.15. ACID RAIN

Acid rain is the rainfall that has been acidified. It is formed when oxides of sulfur and nitrogen react with the moisture in the atmosphere. It is rain with a pH of less than 5.6. Acid rain is particularly damaging to lakes, streams, and forests and the plants and animals that live in these ecosystems.

5.15.1. Types of Acid Deposition

"Acid rain" is a broad term referring to a mixture of wet and dry deposition (form of deposition material) from the atmosphere

(a) Wet Deposition

- If the acid chemicals in the air are blown into areas where the weather is wet, the acids can fall to the ground in the form of rain, snow, fog, or mist.
- As this acidic water flows over and through the ground, it affects a variety of plants and animals.
- The strength of the effects depends on several factors, including how acidic the water is; the

chemistry and buffering capacity of the soils involved; and the types of fish, trees, and other living things that rely on the water.

- Precipitation removes gases and particles from the atmosphere by two processes:

(i) rain-out which is the incorporation of particles into cloud drops which fall to the ground, and

(ii) washout which occurs when materials below the cloud is swept down by rain or snow it falls.

(b) Dry Deposition

- In areas where the weather is dry, the acid chemicals may become incorporated into dust or smoke and fall to the ground through dry deposition, sticking to the ground, buildings, vegetation, cars, etc.
- Dry deposited gases and particles can be washed from these surfaces by rainstorms, through runoff.
- This runoff water makes the resulting mixture more acidic.
- About half of the acidity in the atmosphere falls back to earth through dry deposition.

The pH scale

- The pH scale is a measure of how acidic or basic (alkaline) a solution is.
- It ranges from 0 to 14. A pH of 7 is neutral.
- A pH less than 7 is acidic, and a pH greater than 7 is basic.
- It was devised in 1909 and it is a logarithmic index for the hydrogen ion concentration in an aqueous solution.
- pH values decreases as hydrogen ion levels increases.
- A solution with pH 4 is ten times more acidic than solution with pH 5, and a hundred times more acidic than solution with pH 6.
- Whilst the pH range is usually given as 0 to 14, lower and higher values are theoretically possible.

5.15.2. Sources of compounds causing acid rain

(a) Sulphur

(i) Natural sources:

- seas and oceans,
- volcanic eruptions,
- Biological processes in the soil e.g., Decomposition of organic matter.

(ii) Man-made sources:

- burning of coal (60% of SO_2) and
- petroleum products (30% of SO_2), and
- The smelting of metal sulfide ores to obtain the pure metals.
- Industrial production of Sulfuric acid in metallurgical, chemical and fertilizer industries.

(b) Nitrogen

Natural sources:

- lightening,
- volcanic eruption, and
- Biological activity.

Anthropogenic sources:

- Forest fires
- Combustion of oil, coal, and gas

(c) Formic acid

- Biomass burning due to forest fires causes emission of formic acid (HCOOH) and formaldehyde (HCHO) into the atmosphere.
- Large fraction formaldehyde gets photo - oxidation and forms formic acid in the atmosphere.

These are three main compounds that cause acidification of rain in the atmosphere.

(d) Other Acids:

- Chlorine
- Phosphoric acid
- Hydrochloric acid (smokestacks).
- Carbon monoxide and carbon dioxide (automobiles). These become carbonic acid.

Does it occurs only in industrial areas alone?

SOX and NOX that create Acid Rain are often transported to distances far away from their points of origin by the wind so that the adverse effects of pollution are also experienced at place remote from the place of genesis. The problem is further compounded as the environmental damage caused by acid rain is not uniform, but is area-specific.

5.15.3. Common characteristics of acid rain areas:

Areas which are prone to acid-rain attacks have some common characteristics:

- They are concentrated in the industrialized belt of the northern hemisphere.
- They are often upland and / or mountainous areas, which are well-watered by rain and snow.
- Due to the abundance of water, they possess numerous lakes and streams and also have more land covered with vegetation.
- Being upland, they often have thin soils and glaciated bedrock.

World scenario

Many parts of Scandinavia, Canada, the North and Northeast United States and Northern Europe (particularly West Germany and upland Britain) share these features. Across the Atlantic there are number of acid rain hot spots including Nova Scotia, Southern Ontario and Quebec in Canada, the Adirondack Mountains in New York, Great Smoky mountains, parts of Wisconsin, Minnesota, and the Colorado Rockies of the US.

In India

In India, the first report of acid rain came from Bombay in 1974. Instances of acid rain are being reported from metropolitan cities.

In India, the annual SO_2 emission has almost doubled in the last decade due to increased fossil fuel consumption. Lowering of soil pH is reported from north-eastern India, coastal Karnataka and Kerala, parts of Orissa, West Bengal and Bihar.

Indicators

Lichens serve as good bio-indicators for air pollution. In the variety of pH around 6.0, several animals, those are important food items for fish decline. These include the freshwater shrimp, crayfish, snails and some small mussels.

5.15.4. Chemistry of Acid Rain

Six basic steps are involved in the formation of acid rain:

1. The atmosphere receives oxides of sulfur and nitrogen from natural and man-made sources.
2. Some of these oxides fall back directly to the ground as dry deposition, either close to the place of origin or some distance away.
3. Sunlight stimulates the formation of photo-oxidants (such as ozone) in the atmosphere.
4. These photo-oxidants interact with the oxides of sulfur and nitrogen to produce H_2SO_4 and HNO_3 by oxidation.
5. The oxides are of sulfur and nitrogen, photo-oxidants, and other gases (like NH_3)
6. Acid rain containing ions of sulfate, nitrate, ammonium and hydrogen falls as wet deposition.

Difference between normally and anthro-pogenically acidified lakes

Naturally acidic lakes	Anthropogenically acidified lakes
Brown to yellow colour caused by humic substances	Very clear water caused by reduced primary productivity
Concentrations of dissolved organic carbon are high while transparency is low	Dissolved organic carbon concentrations are low. Whereas the transpa-rency is high.

Low pH but well buffered.	Poorly buffered
Abound with aquatic life.	Some of the more sensitive taxa, such as blue-green algae, some bacteria, snails, mussels crustaceans, mayflies and fish either decrease or / are eliminated.

5.15.5. Impact Of Acid Rain

(a) Soil

- The exchange between hydrogen ions and the nutrient cations like potassium and magnesium in the soil cause leaching of the nutrients, making the soil infertile.
- This is accompanied by a decrease in the respiration of soil organisms.
- An increase in ammonia in the soil due to a decrease in other nutrients decreases the rate of decomposition.
- The nitrate level of the soil is also found to decrease.
- The impact of acid rain on soil is less in India; because Indian soils are mostly alkaline, with good buffering ability.

(b) Vegetation

Acid rains affect trees and undergrowth in forest in several ways, causing reduced growth or abnormal growth:

- The typical growth-decreasing symptoms are:
  - Discoloration and loss of foliar biomass
  - Loss of feeder-root biomass, especially in conifers
  - Premature senescence (aging) of older needles in conifers
  - Increase in susceptibility of damage to secondary root and foliar pathogens
  - Death of herbaceous vegetation beneath affected trees
  - Prodigious production of lichens on affected trees.
  - Death of affected trees.

(c) Micro organisms

- pH determines the proliferation of any microbial species in a particular environment and the rate at which it can produce.
- The optimum pH of most bacteria and protozoa is near neutrality; most fungi prefer an acidic environment, most blue-green bacteria prefer an alkaline environment.
- So after a long run of acid rain, microbial species in the soil and water shift from bacteria-bound to fungi-bound and cause an imbalance in the microflora.
- This causes a delay in the decomposition of soil organic material, and an increase in fungal disease in aquatic life and forests.

(d) Wild life

The effects of acid rain on wild life are not very obvious and are therefore, difficult to document. Nevertheless, several direct and indirect effects of acid rain on the productivity and survival of wildlife populations have been reported.

- Acid rain can directly affect the eggs and tadpoles of frogs and salamanders that breed in small forest ponds.
- It has been postulated that acid rain can indirectly affect wildlife by allowing metals bound on soils and sediments to be released into the aquatic environment, where toxic substances may be ingested by animals, like birds, that feed in such an environment.
- Other indirect effects of acid rain on wildlife are loss or alteration of food and habitat resources.

(e) Humans

Acid rain affects human health is a number of ways.

- The obvious ones are bad smells, reduced visibility; irritation of the skin, eyes and the respiratory tract.
- Some direct effects include chronic bronchitis, pulmonary emphysema and cancer.
- Some indirect effects include food poisoning vis a vis drinking water and food.

- An increase in the levels of toxic heavy-metals like manganese, copper, cadmium and aluminium also contribute to the detrimental effects on human health.

(f) Acid rain damage on Materials

Material	Type of Impact	Principal Air Pollutants
Metals	Corrosion, tarnishing	Sulphur Oxides and other acid gases
Building stone	Surface erosion soiling, black crust formation	Sulphur Oxides and other acid gases
Ceramics and glass	Surface erosion, surface crust formation	Acid gases, especially fluoride-containing
Paints and organic coatings	Surface erosion, discolouration, soiling	Sulphur dioxides, hydrogen sulphide
Paper	Embrittlement, discolouration	Sulphur Oxides
Photographic Materials	Micro-blemishes	Sulphur Oxides
Textiles	Fading, colour change	Nitrogen oxides, ozone
Leather	Weakening, powdered surface	Sulphur oxides
Rubber	Cracking	Ozone

(g) Socio-economic impacts of acid rain:

The adverse impact of acid rain on farming and fishing leads to the deterioration of life quality indices like GNP and per capita income, especially in the predominantly agricultural and developing countries like India

5.15.6. Trigger Effect of Acid Rain on Pollutants:

A low pH of the rainwater and subsequent increased acidity in the environment can trigger off or aggravate the effects of certain harmful pollutants.

(i) Mercury:

- Methyl mercury and related short chain alkyl mercurial compounds are most dangerous to humans, as they accumulate in edible fish tissue.
- Although acid deposition may not increase the production of methyl mercury, it may increase the partitioning of methyl mercury into the water column.
- The use of lime has helped in reducing the mercury levels in fish.

(ii) Aluminium:

- Acidified waters are known to leach substantial amounts of aluminium from watersheds.
- Even at relatively low levels, aluminium has been implicated in dialysis dementia, a disorder of the central nervous system, which may be toxic to individuals with impaired kidney function.

(iii) Cadmium:

- Cadmium can enter the drinking water supply through corrosion of galvanized pipe or from the copper-zinc through corrosion of galvanized piper or from the copper-zinc solder used in the distribution systems.
- A decrease in water pH from 6.5 to 4.5 can result in a fivefold increase in cadmium and could cause renal tubular damage.

(iv) Lead:

- Foetuses and infants are highly susceptible to drinking water lead contamination.
- High blood lead levels in children (>30 mug/ Ml) are believed to induce biochemical and neurophysiological dysfunction.
- However, lower than normal blood levels of lead can cause mental deficiencies and behavioural problems.

(v) Asbestos:

Asbestos in natural rock can be released by acidic waters.

> "Under Smart Cities Mission, first-of-its-kind initiative – Climate Smart Cities Assessment Framework 2019 has been launched which intends to provide clear roadmap for cities and urban India towards combating climate change through adoption of both mitigation and adaptation measures.

5.15.7. Control Measures:

Reducing or eliminating the sources of pollution by

- Buffering- the practice of adding a neutralizing agent to the acidified water to increase the pH is one of the important control measures. Usually lime in the form of calcium oxide and calcium carbonate is used.
- Reducing the emission of SO_2 from power stations by burning less fossil fuel, using alternate energy sources like tidal, wind, hydropower etc.,
- using low sulphur fuel;
- desulphurization
- decreasing emission of NO_x from power stations and
- Modification of engines.
- Emissions of SO_x can be controlled by
  - Converting to sulphuric acid.
  - Converting it to elemental sulphur.
  - Neutralizing it and using it in the manufacture of other products.

5.16. CATEGORIZATION OF INDUSTRIAL SECTORS

- The Ministry of Environment, Forest and Climate Change (MoEFCC) has developed the criteria of categorization of industrial sectors, Red, Orange, Green and White categories based on the Pollution Index which is a function of the emissions (air pollutants), effluents (water pollutants), hazardous wastes generated and consumption of resources. The Pollution Index PI of any industrial sector is a number from 0 to 100 and the increasing value of PI denotes the increasing degree of pollution load from the industrial sector.
- "Re-categorization of industries based on their pollution load is a scientific exercise. The old system of categorization was creating problems for many industries and was not reflecting the pollution of the industries. The new categories will remove this lacuna and will give clear picture to everyone. "The new category of White industries which is practically non-polluting will not require Environmental Clearance (EC) and Consent and will help in getting finance from lending institutions. No Red category of industries shall normally be permitted in the ecologically fragile area / protected area.

CHAPTER - 6

ENVIRONMENTAL ISSUES

6.1. INDIAN HIMALAYAN REGION (IHR) - ENVIRONMENTAL CHALLENGES

The Indian Himalayan Region (IHR), which occupies a strategic position along the entire northern and north-eastern boundary of the country and administratively covers 10 states in their entirety (Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Meghalaya) and two states partially (the hill districts of Assam and West Bengal), has wide ranging ecological and socio-economic significance.

IHR Services

- Besides innumerable goods, IHR generates a plethora of services not only for Himalayan inhabitants but also influences the lives of people living well beyond its boundaries.
- Among other services, the region, with its large area under permanent snow cover and glaciers, forms a unique water reservoir that feeds several important perennial rivers.
- With its vast green cover, IHR also acts as a giant carbon 'sink'.
- IHR also forms a considerably large part of identified Himalayan Biodiversity global hotspot.

Role in Indian climate.

The region, however, is facing environmental problems on account of various factors including the stress caused by anthropogenic activities. Even geologically, the Himalayan ecosystem falls under the most vulnerable category. Therefore the environmental issues being faced by the IHR are of critical importance.

Managing the Himalayan ecosystem sustainably is critical not only for preserving its pristine beauty and spectacular landscapes, but also for ensuring the ecological security of the entire Indian sub-continent.

(A) URBANIZATION IN THE HIMALAYAS - IS IT SUSTAINABLE?

Impact - Solid Waste

The continued expansion in urban settlements, influx of visitors, trekkers and mountaineers in the Himalayan region has started to pose high biotic pressure and concomitant indiscriminate solid waste dumping. As a result, the IHR is getting adversely affected.

In the absence of proper management practices and inadequate infrastructural facilities, human induced pollution, such as solid waste, untreated sewage and local air pollution due to vehicles has been continuously increasing in the IHR.

Impact - Town Planning

Rapid unplanned growth of hill towns, construction activities without a proper plan, general non-compliance with prescribed norms and guidelines, and indiscriminate use of land for commercial outfits/tourist resorts have severely and adversely affected the fragile ecosystem of the Himalayas.

Large scale land instabilities, drying up of natural water sources, waste disposal problems and changing socio-cultural values are known impacts of unplanned construction activities.

Deforestation activities - cutting in an area causes ecological damage and slope instability in adjacent areas.

INITIATIVES

Ban on Plastic in HP

- State government enacted the Himachal Pradesh Non-Biodegradable Garbage (Control) Act, 1995 in order to prevent throwing or depositing non-biodegradable garbage in public drains, roads.
- It has then increased the minimum thickness of plastic carry bags to 70 microns of virgin material, which exceeded the 20 micron thickness recommended by Central Rules.
- Further, the state Government has taken a Cabinet decision to ban plastics altogether in the entire state since 2009.

Participatory Conservation of Lakes in the Region

- The Naini Lake is the sole source of drinking water for Nainital town, an important tourist destination in Uttarakhand state.
- Increasing inflow of tourists, urban waste making its way into the lake is adversely affecting water quality.
- To conserve the water body, the residents have switched on to a scientific garbage disposal system – under the project name 'Mission Butterfly' by Nainital Lake Conservation Project.
- The sweepers, on a small monthly charge, collect waste from each household and directly transfer it to the compost pits. Apart from the residents, schools and hotel owners have extended full cooperation to the authorities, to save its precious eco-system.
- In addition, they are able to generate income and employment by converting it to manure.

Conservation of Dal lake

- Dal Lake a favorite tourist destination attracting thousands of tourists in Jammu & Kashmir state, is also special for settlement of about 60,000 people within the lake.
- The lake is in peril due to anthropogenic pressure and overall deterioration of surrounding environment.
- The lake has been included in the lake conservation programme of the MoEF, GOI.
- The Lake and Waterways Development Authority (LAWDA), Srinagar, in collaboration with Centre for Environment Education (CEE) and other NGOs has taken up the initiative for lake conservation through education and mass awareness. Use of polythene carry bags has also been banned in the lake area.

Assam Hill Land and Ecological Sites Act, 2006

- The Assam Hill Land and Ecological Sites (Protection and Management) Act, 2006 to prevent indiscriminate cutting of hills and filling up of water bodies in urban areas, which had led to serious ecological problems in places like Guwahati.
- Under the Act, the state government can bring any hill under its purview for protection.

Urban Development through JNNURM

- "The aim is to encourage reforms and fast track planned development of identified cities. Focus is to be on efficiency in urban infrastructure and service delivery mechanisms, community participation, and accountability of ULBs/ Parastatal agencies towards citizens".
- The duration of the mission is seven years starting from 2005-06with initially 13 towns.

Recommendations / solutions for Solid Waste Management in IHR

The "development" in the present context has become unsustainable. An integrated approach is, therefore, necessary to protect the environment and achieve required economic development at the same time. Advance planning based on timely and reliable data has become crucial for sustainable growth of hill towns.

1. Guidelines prohibiting indiscriminate disposal of garbage, particularly the non-degradable waste.
2. Preventive and management steps for solid waste management at the point of origin itself.
3. Documentation about the varying composition of waste from the hill towns to expedition tops.
4. Promotion of techniques such as conversion of biodegradable waste into biocompost, or vermicompost in place of land filling, open dumping or burning.
5. The four `R's principle' - Refuse waste prone commodities, Reuse discarded commodities for other uses, Reduce through segregation into categories—biodegradable and non-biodegradable at household/ individual level, and Re-cycling once fully used or completely unusable commodities/ items.
6. Good quality potable water, available at various locations in hill towns so that people can fill their bottles, on payment basis.
7. Awareness and capacity building of the stakeholders.
8. Best international experiences & practices followed in regard to preservation of surroundings and prevention of littering in eco-sensitive places, [e.g., Alaska, Gangotri/Leh region, Nepal and China] should be examined and appropriately adopted.
9. Need support and innovative thinking on different aspects, ranging from traditional architectural practices, local water management and diverse systems of sewage and garbage management.
10. There is a need to motivate residents to switch over to a more scientific waste disposal system in a participatory manner.

Recommendations / solutions - Hill Town Planning and Architectural Norms

1. Fragmentation of habitats in hill areas should be prevented.
2. Specific areas for rural/urban development should be designated.
3. No construction should be undertaken which fall in hazard zones or areas falling on the spring lines and first order streams.
4. Architectural and aesthetic norms for construction of buildings in mountain/hill areas should be enforced.
5. Deforestation activities shall not be undertaken unless appropriate measures are taken to avoid such damages.
6. An integrated development plan may be prepared taking into consideration environmental and other relevant factors
7. In highly seismic areas like Himalaya, all construction should incorporate earthquake resistant features
8. Location-specific technologies should be deployed for construction of buildings
9. "Green roads" having channels for collection of water for irrigation purposes should be made a part of the construction norm.

(B) TOURISM – WILL IT BE REGULATED?

Pilgrimage Tourism in Sensitive Areas

- The Himalayas is known to be a home of saints, destination of pilgrimage since time immemorial.
- For example, Badrinath, Kedarnath, Gangotri-Yamunotri and Hemkund Sahib in Uttarakhand, Manimahesh, Jwala Devi, Chintpurni, Naina Devi in Himachal Pradesh and Vaishnav Devi and Amarnath in Jammu & Kashmir, Khecheopalri and other sacred lakes in Sikkim are particularly important destinations.
- Unfortunately, most of these places lack adequate facilities of transport, accommodation, waste

disposal and other amenities for the ever growing number of pilgrims that visit them every year.

- Also, there is a gross lack of regulatory mechanism for infrastructure creation, management, and for controlling the tourist inflow in such sites.
- As a result the sensitive ecosystems and cultural values of these areas are facing pressures far beyond their carrying capacities.

Impact - of Commercial Tourism

- The impacts of tourism on mountain ecosystems and biological resources are of great concern because of the high biodiversity and environmental sensitivity of the Himalayas.
- Cultural identities and diversity in mountain regions are also under threat by the economic, social and environmental forces associated with mountain tourism.
- In this context, community based ecotourism emerges as one of the sustainable alternatives to the presently practiced commercial tourism in already over saturated hill towns like Nainital, Mussoorrie, Shimla, Kullu-Manali, Gangtok, etc.

INITIATIVES

Harnessing Religious Sentiments for Conservation

There is immense scope of harnessing the religious sentiments of tourists in the right perspectives of conservation and sustainable management of natural resources in the eco-sensitive Himalayan areas.

This can be done through:

(i) Encouraging them to undertake participatory plantation for rehabilitation of degraded areas (e.g., Badrivan initiative of GBPIHED in Uttarakhand).

(ii) Promoting the concept of eco-cultural landscapes (e.g., Demazong – Buddhist landscape, Sikkim, and Apatani eco-cultural landscape, Arunachal Pradesh). Both landscapes are highly evolved with high level of economic and ecological efficiencies.

(iii) Involving them in maintenance and strengthening of sacred groves/landscape (e.g., Sacred Groves of Meghalaya: The tribal communities – Khasis, Garos, and Jaintias, have a tradition of environmental conservation based on religious beliefs and customary law and are protected from any product extraction.

Ladakh Himalayan Homestays- Transforming Local Mindsets towards Snow Leopards

- The Himalayan Homestays programme fosters conservation-based community managed tourism development in remote settlements, by gradually building local capacity and ownership.
- It stands out as an example that aims to be sensitive to both host and visitor expectations without compromising the aspirations of host communities, and at the same time seeks to balance these aspects with conservation of the area's unique cultural and natural heritage.

Highlights of Sikkim's Ecotourism Policy

- "Sikkim - the Ultimate Tourist Destination" is the policy motto of the state. The state is employing a system of environmental fees, and permits for entries, and stay time restrictions in some environmentally sensitive high altitude/ pristine areas.
- Operationalization of tourism in various modes, such as village tourism, nature tourism, wildlife tourism, trekking/adventure tourism, and cultural tourism in the state and institutionalization of tourism management at the community level.
- Promotion and use of local art & craft, cuisines, etc., along with organizing tourism fairs and festivals.
- Imparting training in tourism related service industries.

The efforts made by Sikkim can be a basis of responsible tourism in other Himalayan states.

Adventure tourism

Immense opportunities for adventure cum ecotourism in the Himalayan region (e.g., Annapurna

Conservation Area project, Nepal; Nanda Devi Biosphere Reserve ecotourism approach, Uttarakhand) could be harnessed through community involvement.

Tourism + art and culture

Linking of tourism with initiatives like Rural Business Hubs (RBH), as introduced in North East region, which envisages promotion of quality rural products like handloom, handicrafts, agro products, herbal products, bio-fuel, etc., may be considered as yet another aspect of promoting eco-tourism in the IHR.

Regulated entry

The Government of Uttarakhand has restricted the number of tourists visiting the origin of the river Ganga – Gangotri area to 150 per day.

Recommendations / solutions

However, considering the sensitivity (both cultural and natural) of this region, strict operational guidelines are required to be enforced across IHR with region specific provisions for facilitating and promoting community based ecotourism.

Recommendations / solutions – Regulating Tourism and Pilgrimage to Sensitive Areas

1. Pilgrimage tourism in the Himalaya requires both development and regulation so as to reduce congestion and resultant pollution.
2. The accommodation and road transport infrastructure needs to be developed in pilgrimage sites.
3. The pilgrimage tourism is a kind of "economy class" tourism in the Indian Himalayan Region. Suitable accommodation and other facilities need to be made available accordingly.
4. All existing sites should have adequate provision of garbage disposal and management.
5. An inventory of historical, sensitive and sacred sites including sacred groves should be prepared and their vulnerability should be assessed.
6. The access to such sites of incomparable value through vehicles needs to be restricted beyond a certain zone.

Recommendations / solutions – Promoting Ecotourism and Regulation of Commercial Tourism

1. Eco-tourism villages, parks, sanctuaries and other areas should be identified to establish a primary base for ecotourism.
2. Village communities, especially youths, and rural women should be involved in Ecotourism.
3. Restrictions on the entry of vehicles and visitors per day/ per group should be imposed in sensitive ecological sites.
4. Local art, crafts, cuisines, and dishes should be promoted and made an integral part of tourist experience in order to ensure economic benefits to the locals and their cultural integrity/ entity is not lost.
5. Best practices on commercial trekking should be imposed on a mandatory basis
6. Creation of log/bamboo huts should be promoted in busy mountain areas.

Recommendations / solutions for related segments

Rejuvenation of Springs and Degraded Sites

- Special attention should be paid to recharge of ground water and quality of mountain lakes/ wetlands through restoration of forests.
- Detailed geological mapping should be conducted to identify the spring recharge zone and locate geological structures.
- Nuclear water prospecting technologies should be used to map the water sources and prevent the construction activities in such locations that could damage or adversely affect such sources.
- Engineering measures to protect recharge zone from biotic interferences.
- Social fencing measures, e.g.
  - (i) digging shallow infiltration trenches, mulching.
  - (ii) construction of stone-mud check dams in gullies to store rainwater and check soil erosion; and

(iii) land levelling, maintenance of crop field bunds to allow stagnation of rainwater should be enhanced.

- Vegetative measures with the aim to enhance rainwater infiltration and reduce rainwater runoff.
- Involvement of stakeholder community should be ensured at every step of the Spring Sanctuary Development. The maintenance and aftercare of the interventions have to be ensured through their involvement.

Rain Water Harvesting

- All buildings to be constructed in future in urban areas should have provision for roof-top rain water harvesting
- The institutional and commercial buildings should not draw water from existing water supply schemes which adversely affect water supply to local villages or settlements.
- In rural areas rain water harvesting should be undertaken through such structures as percolation tanks, storage tanks and any other means.
- Spring sanctuary development should be undertaken in the spring recharge zones to augment spring water discharge.
- Rain water collected through storm water drains should be used to clean the waste disposal drains and sewers.
- Ground water aquifer recharge structures should be constructed wherever such structures do not lead to slope instabilities.

Ecologically Safer Roads

- For construction of any road in the Himalayan region of more than 5 km length where the same may not be tarred roads and environmental impact assessment is otherwise not required, environmental impact assessment should be carried out in accordance with the instructions to be issued for this purpose by the State Governments.
- Provision should be made in the design of the road for treatment of hill slope instabilities resulting from road cutting, cross drainage works and culverts using bio-engineering and other appropriate techniques.
- Provisions should be made for disposal of debris from construction sites in appropriate manner at suitable and identified locations so as not to affect the ecology of the area adversely.

Further, the dumped material should be treated using bio-engineering and other appropriate techniques.

- No stone quarrying should be carried out without proper management and treatment plan including rehabilitation plan.
- All hill roads should be provided with adequate number of road side drains and these drains shall be kept free from blockage for runoff disposal; further, the cross drains shall be treated suitably using bio-engineering and other appropriate technologies so as to minimise slope instability.
- The runoff from the road side drains should be connected with the natural drainage system in the area.
- Fault zones and historically land slide prone zones should be avoided during alignment of a road, where for any reason it is not possible to do so, the construction should be carried out only after sufficient measures have been taken to minimize the associated risks.
- Ridge alignment should be preferred to valley alignment.
- Alignment should be selected so as to minimise loss of vegetal cover.
- Encouragement should be provided for use of debris material for local development.

6.2 SAND MINING IN INDIA - ENVIRONMENTAL ISSUES

Sand is an important mineral for our society in protecting the environment, buffer against strong tidal waves and storm, habitat for crustacean species and marine organisms, used for making concrete, filling roads, building sites, brick making, making glass, sandpapers, reclamations, and in our tourism industry in beach attractions.

Sand mining is the process of removal of sand and gravel where this practice is becoming an environmental issue as the demand for sand increases in industry and construction.

Despite a Supreme Court order that prohibits sand mining without the requisite clearance from the required authorities and places limits on the quantities that can be mined, thousands of tonnes of sand is being illegally mined to meet the rising demand of construction industry and for extraction of minerals. Let's discuss about the scenario of sand mining in India

The environmental reasons for this ban and others across India are numerous. Sand acts as an aquifer, and as a natural carpet on the bottom of the river. Stripping this layer leads to downstream erosion, causing changes in channel bed and habitat type, as well as the deepening of rivers and estuaries, and the enlargement of river mouths. As the river system lowers, local groundwater is affected, which leads to water scarcities aggravating agriculture and local livelihoods.

In terms of legal measures, ground water shortages have been noted as the patent problem with river sand mining. Less considered in legal action, but centrally relevant, experts also note substantial habitat and ecological problems, which include "direct loss of stream reserve habitat, disturbances of species attached to streambed deposits, reduced light penetration, reduced primary production, and reduced feeding opportunities".

Economic consequences of sand mining

1. Revenue loss to the exchequer

   For e.g.: It is estimated that in Noida and Greater Noida alone the loss to the exchequer is about Rs.1,000 crore, but the impact that sand mining, which is simply put theft on environment and ecology, cannot even be calculated.

Environmental consequences of sand mining

1. Forcing the river to change its course

   Sand and boulders prevent the river from changing the course and act as a buffer for the riverbed.

2. Illegally dredged sand is equivalent to robbing water.

   Sand holds a lot of water, and when it is mindlessly mined and laden on to trucks, large quantities of water is lost in transit.

3. Depletion of groundwater tables

   Sand, on a riverbed it acts as a link between the flowing river and the water table and is part of the aquifer.

   For e.g.: Illegal and excessive sand mining in the riverbed of the Papagani catchment area in Karnataka has led to the depletion of groundwater levels and environmental degradation in the villages on the banks of the river in both Andhra Pradesh and Karnataka.

4. Adversely impacting the habitat of micro-organisms

   There are a lot of micro-organisms that are not visible and widely known, but are critical to soil structure and fertility. When sand is dredged, literally it takes away their habitat.

5. Increased river erosion

   When sand and boulders are removed in an unimpeded way using heavy machines, the erosion capacity of the river increases.

6. Damage to roads and bridges

   For e.g.: In Vishnuprayag the boulders that came down with the river water damaged a side of the dam and the waters spread out across causing heavy damage.

7. Threat to agriculture

   For e.g.: Despite numerous prohibitions and regulations, sand mining continues rapidly on the riverbed of the Bharathapuzha in kerala. Water tables have dropped dramatically and a land once known for its plentiful rice harvest now faces scarcity of water. In the villages and towns around the river, groundwater levels have fallen drastically and wells are almost perennially dry.

8. Damage to coastal ecosystem

   This destructive illegal practice in beaches, creeks leads to erosion along the shoreline. Eg: Kihim

Beach off Alibaug, Shore levels have reduced, forcing residents to build walls to protect themselves from the sea.

It wrecks the intertidal area and creates the imminent danger of saline water ingress into fresh water.

Coastal sand mining destroys fisheries, disturbs coral, mangroves, wetlands and has led to the near extinction of ghariyals, a crocodile species unique to India.

A major impact of beach sand mining is the loss of protection from storm surges associated with tropical cyclones and tsunamis.

9. Lesser availability of water for industrial, agricultural and drinking purposes.
10. Loss of employment to farm workers.
11. Threat to livelihoods.

Current rules and policies in operation relation to sand mining

Kerala: Kerala Protection of River Banks and Regulation of Removal of Sand Act, 2001

Key features: To permit sand mining in select areas and each selected area or Kadavu will be managed by a Kadavu Committee which will decide on matters such as quantum of mining to be permitted, and to mobilise local people to oversee these operations and ensure protection of rivers and riverbanks.

Key rivers affected: Bharatapuzha, Kuttiyadi river, Achankovil, Pampa and Manimala, Periyar, Bhavani, Siruvani, Thuthapuzha, and Chitturpuzha, rivers in the catchments of Ashtamudi and Vembanad lakes

Tamil Nadu: Policy that ensures that quarrying of sand in Government poramboke lands and private patta lands will only be undertaken by the Government. Mechanised sand mining is prohibited. In 2008, this policy was countermanded by the government and private parties were given permits for mining.

Rivers affected: Cauvery, Vaigai, Palar, Cheyyar, Araniyar and Kosathalaiyar, Bhavani, Vellar , Vaigai Thamiraparani, Kollidam. coastal districts of Nagapattinam, Tuticorin, Ramanatha-puram and Kanyakumari. hill regions of Salem and Erode districts.

Karnataka: The Uniform Sand Mining Policy does not allow sand mining in Coastal Regulation Zone (CRZ) area and prohibits the use of machineries to mine sand from river. High Court of Karnataka banned mechanised boats for sand mining in the state from April 2011.

From September 2011, according to Karnataka Minor Mineral Concession (Amendment) Rules 2011,the responsibility of oversight of sand mining has been transferred to the Public Works, Ports and Inland Water Transport Department.

Rivers affected: Cauvery, Lakshmanateerta, Harangi, Hemavathi, Nethravatai, Papagani

Andhra Pradesh: In 2006, a new policy that allows only manual labour and bullocks to mine sand in riverbeds. Bullock carts, mules and other animals would be exempted from any mining tax. Contractors will be allotted sand through open bidding by a committee headed by district joint collectors. Sand can be sold only if it has a maximum retail price tag, otherwise there will be a penalty. Use of poclaines has been banned entirely, and mining will be disallowed below three metres.

Rivers affected: Godavari, Tungabhadra, Vamsadhara, Nagavali, Bahuda and Mahendratanaya

Maharashtra: New policy, 2010, under which it is compulsory for contractors to obtain permission from the Gramsabha, for sand mining. Ban on use of suction pumps in dredging and sand mining licences can be given only through a bidding process. Also sand mining projects have to obtain environmental clearances.

Rivers affected: creeks at Thane, Navi Mumbai, Raigad and Ratnagiri

Uttar-Pradesh: the Noida administration established a "Special Mining Squad," charged with the specific task of impeding and ultimately extricating Greater Noida from the sand mafia's degradation.

Rivers affected: Chhoti Gandak, Gurra, Rapti and Ghaghara.

Suggestions

1. The most viable alternative is 'manufactured sand'. It is produced in a stone crushing plant. M-sand is produced from stones which is used for aggregates, and the quality is consistent and even better than river sand. M-sand is relatively cheaper too.
2. Use of fly ash from industries as alternative should be promoted for construction purposes.
3. The government should exercise prudence when it comes to leasing out the riverbed for mining activities and also demarcate areas clearly and monitor mining through a suitable institutional mechanism.
4. Periodic assessment of how much sand can be sustainably mined, as the quantity can vary from a river to river and within a river from stretch to stretch has to be done.
5. The use of intrusive techniques such as the use of explosives and heavy excavator machines in sand mining are largely destructive.
6. In the mountain areas especially sand mining should be carried out manually and sustainably.
7. A high level lobbying committee must be formed and Laws has to be enforced in an efficient and unbiased way and decisive steps are to be taken for environmental solution.

Guidelines for Sustainable Sand & Minor Mineral Mining

1. Where to mine and where to prohibit mining: District Survey Report for each district in the country, taking the river in that district as one ecological system. Use of ISRO, remote sensing data and ground truthing.
2. Sustainable mining: Mining out material only that much which is deposited annually.
3. Involvement of District authorities in the process: The District-level Environment Impact Assessment Authority (DEIAA) headed by District Collector.

   The District Collector is to be assisted by the District Level Expert Appraisal Committee (DEAC) headed by Executive Engineer (Irrigation Department) being assigned the responsibility of granting environment clearance up to 5 hectare of mine lease area for minor minerals , mainly sand. So district administration, which is the key in assessing the requirement of sand in a district and prohibiting illegal sand mining in district is being involved directly in environmental clearance.
4. Monitoring using scientific tools: Stringent monitoring of movement of mined out material from source to destination using information technology tools, bar coding, SMS etc. Till date, there is no authentic data on how much sand is being mined, this system will generate real-time data on mined out sand. The movement of sand is controlled through Transit Permit.

   The monitoring of mined out mineral, Environmental Clearance, EC conditions and enforcement of Environment Management Plan (EMP) will be ensured by the District Collector and the State Pollution Control Board. The monitoring of enforcement of EC conditions can be done by the Central Pollution Control Board, Ministry of Environment, Forest and Climate Change and the agency nominated by Ministry for the purpose.
5. Exemptions: Proposal to exempt certain category from mining for the purpose of environmental clearance, like:
   - i. Extraction of ordinary clay or ordinary sand manually by hereditary Kumhars (potters) who prepare earthen pots on a cottage industry basis.
   - ii. Extraction of ordinary clay or ordinary sand manually by earthen tile makers who prepare earthen tiles on a cottage industry basis.
   - iii. Removal of sand deposited on agricultural field after flood by owner farmers.

iv. Customary extraction of sand and ordinary earth from sources situated in Gram Panchayat for personal use or community work in a village.

v. Community works like desilting of village ponds/tanks, construction of village/rural roads, bunds undertaken in MGNREGS and other Government-sponsored schemes.

vi. Dredging and desilting of dam, reservoirs, weirs, barrages, river and canals for the purpose of maintenance and upkeep, and the dredged material is used departmentally. If the dredging activities are undertaken for the purpose of winning of mineral and selling it commercially, it will be considered mining and prior EC will be required.

6. Guideline on handling cluster issues: The original EIA notification does not provide for the procedure to handle cluster situation, which has been proposed in this guideline and will become part of the Notification. One EIA/EMP will be prepared for one cluster irrespective of number and size of mining leases in that cluster, if the area is more than 5 hectares. Area less than 5 hectare will be B2.

6.3 PALM OIL – ENVIRONMENTAL ISSUES AND INDIA'S ROLE IN IT

When forest shrink, so does the home of endangered species

Palm oil has emerged as the main global source of vegetable oil due to adequate availability, versatility in usage, higher yield and lower cost, as compared to other vegetable oils. Palm oil is generally sold in the name of vegetable oil.

Palm oil forms 33% of the world vegetable oil production mix. Indonesia and Malaysia contribute almost 87% of production of palm oil, whereas China and India constitute 34% of imports.

Global edible oil consumption has grown from 123 Million Metric tonnes in 2007 to 158 Mn MT in 2012. This growth has been fuelled by increased population, incomes and per capita consumption especially in developing countries like India, Indonesia and China, etc. Palm oil, at 48.7 Mn MT is the largest consumed edible oil in the world.

As demand for palm oil increases, substantial tracts of tropical forests are often cleared to make room for large plantations. As per WWF's estimates, the expansion of oil palm plantations is likely to cause four million hectares (more than twice the size of Kerala) of forest loss by 2020.

Deforestation would most likely occur in high biodiversity areas, such as Borneo, Papua New Guinea, Sumatra and the Congo Basin in Africa. The felling and burning of forests impact populations of endangered wildlife such as Sumatran Tigers, Rhinos and Orangutans. It also has adverse impacts on people's health and disrupts local livelihoods.

At the global level, the impacts of forest loss are even more dramatic, including the release of greenhouse gases into the atmosphere that contribute to global warming.

Applications of Palm Oil

1) Food based applications

   Cooking oil, substitute for butter, vanaspati/vegetable ghee, margarine, confectionary and bakery fats, ice cream, coffee creamers, emulsifiers, vitamin E supplements among others.

2) Non-food applications

   Cosmetics, toiletries, soaps and detergents. Oleo chemical industry, as a base material for laundry detergents, household cleaners and cosmetics.

According to USDA estimates, 75% of the global palm oil consumption is for food purposes, while 22% is for industrial/non-food purposes. The remaining, though currently, of marginal quantity, is used for biodiesel

Environmental Impacts of Palm Oil Production

1. Deforestation – Substantial tracts of tropical forests are cleared to make room for large plantations to service an ever increasing demand for palm oil. Studies show that the forest cover on the island of Borneo had declined from 73.7

percent in 1985 to 50.4 percent in 2005, while the projected cover in 2020 was 32.6 percent. Loss of forest cover in Sumatra, Indonesia, has also been very alarming.

2. Loss of biodiversity – Concerns about biodiversity loss are directly related to the loss of natural forests. In particular, orangutan habitats have been threatened by palm oil production. In 1900, there were around 315,000 orangutans in Indonesia and Malaysia. Today, fewer than 50,000 exist in the wild, split into small groups. The palm oil industry is the biggest threat to orangutans, with the species like to be driven to extinction within 12 years unless the devastation of their natural habitat is halted. A related problem has been that fragmentation of natural forest habitats and encroachment by palm oil development which has been resulted in serious human- wildlife (elephant, etc) conflicts.
3. Climate change – 15% of all human induced greenhouse gas emissions are caused by deforestation, forest degradation and peat land emissions. As land on mineral soil becomes less readily available, the expansion of oil palm is increasing on peat lands. . As these areas are drained, the peat is exposed to oxidation, resulting in significant CO2 release over an extended period. Other significant sources of GHG emissions associated with oil palm are the use of fires for land clearing and the emissions of methane from the effluent treatment ponds of palm oil mills. Forests are felled, peat swamps drained and burnt, creating a haze that covers large areas, affecting people's health and disrupting economic activities.
4. Use of pesticides and fertilizers – Misuse of pesticides and fertilizers is frequently cited as a negative impact of oil palm cultivation. In general, pesticide use is low compared to many other crops, but some chemicals used, pose significant risks to operators and smallholders and the environment. Among these hazardous chemicals, the herbicide paraquat gives the most cause for concern, as it poses serious health hazards to the spray operators. The Pesticides Action Network-Asia & the Pacific has called for a ban on paraquat production and use on numerous occasions, but to no avail.

India and Oil Palm

Indonesian palm oil companies produce palm oil by destroying virgin rainforests and tiger habitat in Indonesia. Indian huge palm oil imports from Indonesia is been accelerating the destroyal of rainforest. India's palm oil demand destroying Indonesia's rainforests.

The expansion of palm oil plantations to meet the global demand for vegetable oils (palm oil usually used in this name) happens at the expense of forest, wildlife and communities.

Consumption of palm oil in India

Palm oil has dominated Indian imports since the last two decades, for its logistical advantages, contractual flexibility, and consumer acceptance change in consumption patterns, availability, pricing, and policy changes. India is the largest importer of palm oil which is also the lowest priced oil. Palm oil contributes to around 74% (as of 2012) of the total edible oils that are imported into the country.

Almost 90% of the palm oil imported and produced domestically is used for edible/ food purposes, while the remaining is used for industrial/non-edible purposes. Palm oil is now the single largest consumed vegetable oil in India.

Palm oil in India – Production

Despite being the world's fourth largest oilseed producing country, India's share of palm oil production is small, accounting for 0.2% share in the total world produce

Palm oil production in India has grown at 22.7% CAGR over the past five years in 2011. However, India would continue to be a net importer of palm oil.

State-wise Palm Oil Production in India

Andhra Pradesh is the leading palm oil producing state in India contributing approximately 86 % of country's production, followed by Kerala (10%) and

Karnataka (2%). Other palm oil producing states include Orissa, Tamil Nadu, Goa and Gujarat.

Major constraints in domestic cultivation of oil palm

- **Geographical location:** The ideal locations for oil palm trees are within eight degrees latitude north and south of the Equator.
- **Irrigation:** Palms need regular rainfall throughout the year. However, they can withstand dry periods of 3-4 months depending on soils type without irrigation. Oil palm can be grown in Kerala, Andhra Pradesh, Karnataka, Goa and a few other areas, but only with irrigation. This places significant pressure on the hydrological system of the region.
- **Long gestation periods:** Oil palm has very high productivity when compared to other oilseeds like mustard, however, the farmers would have to wait for four years for the trees in India to obtain yield.
- Small farm holdings with Indian farmers generally are challenging.
- Limited investments by corporate sector compared with Malaysia and Indonesia.

Policies Related to Production and Distribution of Palm Oil

Subsidies for distribution of imported palm oil:

The Ministry of Food has been subsiding imported edible oil distribution under the public distribution system (PDS):

- To provide relief, in particular BPL households, from the rising prices of edible oils, the Central Government introduced a scheme for distribution of upto 10 lakh tons of imported edible oils in 2008-09 at a subsidy of rs 15/- per kg through State Governments/UTs.
- The scheme was extended during 2009-10, 2010-2011 and in 2011-12. After the implementation of the scheme, edible oil prices have substantially declined and poorer sections were provided edible oils at subsidized rates.

Oil Palm Development Programme in India:

- OPDP was launched during 1991- 92 under the "Technology Mission on Oilseeds and Pulses" (TMOP), with a focus on expansion of area under oil palm cultivation.
- From 2004-05, the scheme is being implemented as part of the "Integrated Scheme of Oilseeds, Pulses, Oil Palm & Maize" (ISOPOM) and provides support for oil palm cultivation in 12 states: Andhra Pradesh, Assam, Gujarat, Goa, Karnataka, Kerala, Maharashtra, Mizoram, Orissa, Tamil Nadu, Tripura & West Bengal.

For the year 2011-12, the government rolled out the Oil Palm Area Expansion (OPAE) Programme in order to bring an additional 60,000 hectares area under oil palm cultivation.

- The government has also announced various subsidies for oil palm growers for planting, buying pump set and drip-irrigation systems, partial compensation in case of loss during the gestation period and support for processing units.

Roundtable on Sustainable Oil (RSPO)

The RSPO was established in 2004 to promote the production and use of sustainable palm oil for people, planet and prosperity

RSPO is a membership based organisation with oil palm growers, palm oil processers and traders, consumer good manufactures, NGOs and retailers.

8 principles for growers to be RSPO certified

- commitment to transparency
- compliance with applicable laws and regulations
- commitment to long term economic and financial viability
- use of appropriate best practices by growers and millers
- environmental responsibility and conservation of natural resources and biodiversity
- responsible consideration of employees, and of individuals and communities affected by growers and mills

- responsible development of new plantings
- commitent to continous improvement in key areas of activity

RSPO impact

- Presently 14 % of palm oil globally is certified by RSPO

It is however important to understand that palm oil itself is not the problem, but rather how palm oil is produced. When done right, palm oil can be a catalyst for development and to improve livelihoods. It can also enhance biodiversity and sequestrate carbon di oxide when planted on degraded lands.

To ensure an uninterrupted supply of 'clean' palm oil that does not involve sacrificing the remaining tropical forests or contributing to global warming and other social problems, all companies that produce, trade or use palm oil need to move towards sustainable palm oil.

When forest shrink, so does the home of endangered species

6.4. COLONY COLLAPSE DISORDER

Bees are one of a myriad of other animals, including birds, bats, beetles, and butterflies, a called pollinators. Pollinators transfer pollen and seeds from one flower to another, fertilizing the plant so it can grow and produce food. Cross-pollination helps at least 30 percent of the world's crops and 90 percent of our wild plants to thrive. Without bees to spread seeds, many plants – including food crops – would die off.

Bees are not summertime nuisance, they are small and hard-working insects actually make it possible for many of your favorite foods to reach your table. From apples to almonds to the pumpkin in our pumpkin pies, we have bees to thank. Now, a condition known as Colony Collapse Disorder is causing bee populations to plummet, which means these foods are also at risk.

Colony Collapse Disorder (CCD) is a new tagname presently being given to a condition that is characterized by an unexplained rapid loss of a Bee colony's adult population.

Sudden loss of a colony's worker bee population with very few dead bees found near the colony. The queen and brood (young) remained, and the colonies had relatively abundant honey and pollen reserves. But hives cannot sustain themselves without worker bees and would eventually die. This combination of events resulting in the loss of a bee colony has been called Colony Collapse Disorder (CCD).

Reduction or loss of bee population has been seen in the history and known by the name such as disappearing disease, spring dwindle, May disease, autumn collapse, and fall dwindle disease

Symptoms

- Contain no adult bees, with few to no dead bees around the colony
- Contain capped brood
- Contain food stores that are not robbed by neighboring bees or colony pest
- Worker bees failed to return to colony from flight

Causes

The problem is that there doesn't seem to be a single smoking gun behind CCD but a range of possible causes, including:

Global warming

Global warming causes flowers to bloom earlier or later than usual. When pollinators come out of hibernation, the flowers that provide the food they need to start to start the season has already bloomed.

Pesticide (neonicotinoids, a neuroactive chemical)

It's not that the pesticides which are aimed at other insects are killing the bees outright. Rather that sublethal exposure of pesticides in nectar and pollen may be interfering with the honeybees internal radar, preventing them from gathering pollen and returning safely to the hive.

Varroa mite - parasites

European foulbrood (A bacterial disease that is increasingly being detected in U.S. bee colonies) microsporidian fungus Nosema.

Malnutrition

Beekeepers collect (steal) bees honey so humans can consume it, they are taking away the insects' food. They replace it with high-fructose corn syrup, leaving the bees malnourished and weakening their immune systems.

Researchers have identified some specific nutrients that bees need, get from honey, and don't get from corn syrup.

When honeybees collect nectar from flowers, they also gather pollen and a substance called propolis, which they use to make waxy honeycombs. The pollen and propolis are loaded with three types of compounds that can help the bees detoxify their cells and protect themselves from pesticides and microbes.

Metal Pollution

Bees absorbing metal pollution from flowers that absorbed it from the soil that absorbed it from modern machines and vehicles

Stress

The stress of shipping bees back and forth across the country, increasingly common in commercial beekeeping, may be amplifying the stress on the insects and leaving them more vulnerable to CCD.

Habitat loss

Habitat loss brought by development, abandoned farms, growing crops without leaving habitat for wildlife and growing gardens with flowers that are not friendly to farmers.

How can we Protect Bees?

- Policy makers must take action to protect the bees and other pollinators.
- Farmers must be rewarded for practices that help wild bee populations thrive.
- Assistance should be provided to farmers who plan to support a wider variety of pollinators beyond just bees.
- Bee research must be strengthened, and must also be broadened to include research on pollinators besides honey bees.
- Integrated Pest Management (IPM) techniques should be used to minimize pesticide us and risk to bees.
- City dwellers can also practice IPM where they live, work, and play to protect our health, water quality, and pollinators.

And if CCD continues, the consequences for the agricultural economy — and even for our ability to feed ourselves — could be dire.

"No more Bees, No more Pollination, No more Plants, No more Animals, No more Man".

Neonicotinoids

Neonicotinoids are a new class of insecticides chemically related to nicotine. The name literally means "new nicotine-like insecticides". Like nicotine, the neonicotinoids act on certain kinds of receptors in the nerve synapse. They are much more toxic to invertebrates, like insects, than they are to mammals, birds and other higher organisms.

Neonicotinoids share a common mode of action that affect the central nervous system of insects, resulting in paralysis and death.

One thing that has made neonicotinoid insecticides popular in pest control is their water solubility, which allows them to be applied to soil and be taken up by plants. Soil insecticide applications reduce the risks for insecticide drift from the target site, and for at least some beneficial insects on plants.

They include imidacloprid, acetamiprid, clothianidin, dinotefuran, nithiazine, thiacloprid and thiamethoxam.

Uncertainties prevail since their initial registration regarding the potential environmental fate and effects of neonicotinoid pesticides, particularly as they relate to pollinators.

Studies conducted in the late 1990s suggest that neonicotinic residues can accumulate in pollen and nectar of treated plants and represent a potential risk to pollinators. There is major concern that neonicotinic pesticides play a role in recent pollinator declines.

Neonicotinods can also be persistent in the environment, and when used as seed treatments, translocate to residues in pollen and nectar of treated plants.

New research points out potential toxicity to bees and other beneficial insects through low level contamination of nectar and pollen with neonicotinoid insecticides used in agriculture. Although the low level exposures do not normally kill bees directly, they may impact some bee's ability to foraging for nectar, learn and remember where flowers are located, and possibly impair their ability to find their way home to the nest or hive.

In April 2013, the European Commission decided to introduce a 2-year moratorium in EU on the 3 neonicotinod compounds—clothianidin, imidacloprid, and thiamethoxam—following reports by the European Food Safety Authority (EFSA) saying the substances pose an "acute risk" to honey bees essential to farming and natural ecosystems.

6.5 WILDLIFE (ELEPHANT, LEOPARD, ETC) DEATHS DUE TO COLLISION WITH TRAINS

Such accidents pose a grave danger to wildlife, and to the conservation of our national biodiversity.

Article 48A (DPSP) of the Indian Constitution, it is stated that the State shall endeavor to protect and improve the environment and to safeguard the forests and wild life of the country.

Article 51A (Fundamental Duties) to protect and improve the natural environment including forests, lakes, rivers and wild life and to have compassion for living creatures

It is the duty of every citizen to preserve, protect and nourish our wildlife heritage, particularly since these animals are helpless in facing the challenge of biotic pressure.

What has to be done?

- Coordination between MoEF and Railways has to be enhanced to ensure the safety of wildlife.
- Vulnerable patches for wildlife to be identified as wild life crossing spots, and signage put up to warn train drivers and other railway personnel, to enable them to give directions for trains to slow down their speed in these patches in the normal course.
- Update the list of well known vulnerable patches for wild life, and conveying them to the Railways.
- Electronically tag prominent wildlife like elephants, leopards, etc particularly in high traffic areas, so that wildlife and forest personnel could keep track of their movements, and warn railway officials well in time to enable them to avoid accident. Once they are electronically tagged, forest personnel could track their movements, and keep them from harm.
- Improvement in infrastructure for forest and Railway staff, such as, equipped with walkie talkies, constant connection with the control room, etc.
- In prominent wildlife areas, or wherever considered necessary, forest officials should be posted at Railway control rooms to coordinate with railway staff, informed regarding the movement of elephants, to enable railway authorities to take preventive action, well in advance.
- Strict instructions to all railway and forest field personnel, emphasizing the importance of the protection and conservation of wild life.

6.6. IMPACT OF RADIATION FROM MOBILE PHONE TOWERS ON HUMAN BEINGS AND WILDLIFE

The remarkable increase in mobile phones users in the country and mushrooming of mobile tower installations in every nook and corner of cities and towns have raised concerns on its probable impact on wildlife and human health.

Health Impacts

Every antenna on cell phone tower radiates electromagnetic power. One cell phone tower is being used by a number of operators, more the number of antennas more is the power intensity in the nearby area. The power level near towers is higher and reduces as we move away.

How the cell phone tower's radiation affects the birds and bees?

- The surface area of bird is relatively larger than their body weight in comparison to human body so they absorb more radiation.
- Also the fluid content in the body of the bird is less due to small body weight so it gets heated up very fast.
- Magnetic field from the towers disturbs birds' navigation skills hence when birds are exposed to EMR they disorient and begin to fly in all directions.
- A large number of birds die each year from collisions with telecommunication masts.

How the cell phone tower's radiation affects human?

- EMR may cause cellular and psychological changes in human beings due to thermal effects that are generated due to absorption of microwave radiation.
- The exposure can lead to genetic defects, effects on reproduction and development, Central Nervous System behaviour etc.
- EMR can also cause non thermal effects which are caused by radio frequency fields at levels too low to produce significant heating and are due to movement of calcium and other ions across cell membranes.
- Such exposure is known to be responsible for fatigue, nausea, irritability, headaches, loss of appetite and other psychological disorders.
- The current exposure safety standards are purely based on the thermal effects considering few evidences from exposure to non thermal effects.

What are the responsibilities of Stake holders?

MoEF:

- The MoEF has to notify the impacts of communication towers on wildlife and human health to the concerned agencies for regulating the norms for notification of standards for safe limit of EMR.

State/Local Bodies:

- Regular monitoring and auditing in urban localities/ educational/hospital/ industrial/ residential/ recreational premises including the Protected Areas and ecologically sensitive areas.
- Carry out an 'Ecological Impact Assessment' before giving permission for construction of towers in wildlife and ecologically important areas.

State Environment and Forest Department:

- State Environment and Forest Department are entrusted with the task of providing regular awareness among the people about the norms on cell phone towers and dangers of EMR from them.

Department of Telecommunications:

- Avoid overlapping of high radiation fields. New towers should not be permitted within a radius of one kilometer of the existing tower.
- The location and frequencies of cell phone towers and other towers emitting EMR should be made available in the public domain
- GIS mapping of all the cell phone towers to be maintained to monitor the population of bird and bees in and around the wildlife protected area and the mobile towers.
- Need to refine the Indian standard on safe limits of exposure to EMR, keeping in view the available literature on impacts on various life forms
- To undertake Precautionary approaches to minimize the exposure levels and adopt stricter norms

Other agencies

- Any study conducted on impact of EMF radiation on wildlife needs to be shared to facilitate appropriate policy formulations.

6.7 GENETICALLY ENGINEERED (GE) TREES

The proponents of biotechnology industry claim that trees that are genetically altered grow faster and yield better quality of wood in extreme temperatures. Thus they are a boon to forestry in dealing with climate change.

Historical background

The first field trials of GE trees were started in Belgium in 1988, when researchers began to develop poplar trees that were herbicide resistant and that could grow faster. In 2002, China established commercial GE poplar trees plantation as a strategy to address the issue of deforestation. Initially GE trees were established in 300 hectares, and now China has embraced the GE technology on a large scale, integrating this into forestry sector. Latin American countries like Brazil and Argentina, the forerunners in GM food crops are also working on GE trees to enhance the production of pulp and paper.

Is GE trees safer than GM crops?

For:

The proponents of the technology claim that GE trees are safer and there is no need to fear about negative consequences. Already the United Nations has approved plantations of GE trees as carbon sinks under Kyoto Protocol's clean development mechanism. With this stamp of approval, many countries would like to adopt the technology and establish GE plantations.

Against:

Environmentalists state that this technology poses as serious a threat as GM crops. The trees are perennial, that live longer than agricultural crops. The changes in the metabolism of trees may occur many years after they are planted, and trees are wild, undomesticated. This makes it difficult to decipher as to how the introduced gene will behave in natural environment. This fact implies that the ecological risks associated with GE trees are far greater than the agricultural crops.

It has also been documented that the tree pollen travels a distance of more than 600 km. The probability that the GE tree pollen is likely to contaminate vast expanses of native forests with a wide variety of destructive traits may be a threat to ecological balance and the existing biodiversity of the tropical forests in global south. The contaminated pollen might pose threat to honey bees, adversely impacting pollination in the wild and on agriculture crops.

Who are behind developing GE trees and why?

It is ArborGen a subsidiary of Monsanto, oil companies like British Petroleum and Chevron that are investing in this technology. For these companies GE trees offer a viable alternate to fossil fuels as GE trees could produce ethanol, a green fuel. As the ethanol produced from food stocks came under attack, the companies see bright future in non-food cellulose feedstock like GE trees.

In India

The first experiment with genetically engineered tree was with rubber tree developed by the Rubber Research Institute in Kerala. The GE rubber are better adapted to drought resistance and increased environment stress tolerance. This will help to establish rubber in non traditional areas where the conditions are not favourable. Ironically the field trials for GE rubber trees were approved by the then environmental minister (Mr. Jairam Ramesh). Ministry asserted that the genetically modified trees posed lesser threat in comparison to the food crops.

This assumption is baseless as the seeds of rubber tree are used as cattle feed, that gets into the food chain through milk. Similarly, Kerala is one of those regions that produce large quantity of rubber honey from rubber plantations. Kerala, a GM free state worried about the implications of GE rubber on biodiversity, has voiced its concern about bio safety issues. Now the rubber trees are being experimented in Maharashtra.

These developments show the predominance of the western forestry science that lays emphasis on forests as a commercial entity to produce wood and pulp. Diverse forests were simplified by removal of multiple species and establishing monocultures that had commercial value. Already the country's landscape is scarred with millions of hectares of teak and eucalypts mono culture plantations. This approach has had negative consequences for the environment, biodiversity and the local indigenous people. The same trend will be reinforced with the establishment of GE tree plantations, leading to further devastation of the natural environment and forests.

6.8 MOEF BANNED DOLPHIN CAPTIVITY

Ministry of Environment and Forests has banned dolphin captivity within India. This opens up a whole new discourse of ethics in the animal protection movement in India.

The unprecedented decision is particularly significant because it reflects an increasing global understanding that dolphins deserve better protections based on who – rather than what – they are.

Dolphinariums in India

India's only experience of keeping dolphins was in the late 1990s. Four dolphins were imported from Bulgaria to Chennai's Dolphin City, a substandard marine-themed amusement show, where they died within 6 months of arrival.

New proposals

Several state governments had recently announced plans for the state tourism development corporations to establish dolphinariums for commercial dolphin shows. Dolphins are a major tourist attraction at amusement parks abroad.

The major proposals that were made for similar establishments were by the Maharashtra Tourism Development Corporation, the Kerala fisheries department in Kochi and a few private hoteliers in Noida in the National Capital Region.

Why ban?

Cetaceans, including whales, dolphins and porpoises, are known to be highly intelligent animals. However, they do not adjust well to living in captivity. Confinement alters their behaviour and causes extreme distress.

The captivity industry exploit the lives of dolphins by denying them freedom and being allowed to cause them harm and the captivity industry has become adept at hiding the harm they cause to dolphins in their care.

Despite the fact that some humane laws exist to prevent unnecessary cruelty, animals are still considered property and are usually denied the basic rights of life, liberty or freedom from harm.

The rights include not to be captured, confined, or killed, in order to prevent the suffering that they most likely experience when these rights are violated.

Several countries, including Brazil, the United Kingdom and Chile, have banned dolphins in captivity.

The move by MoEF came after months of protests against a proposed dolphin park in the southern state of Kerala and plans for several other marine mammal parks in other parts of the country.

MoEF order

According to the circular released by the Central Zoo Authority, states that because dolphins are by nature "highly intelligent and sensitive," they ought to be seen as "nonhuman persons" and should have "their own specific rights." It says that it is "morally unacceptable to keep them captive for entertainment purposes."

MoEF has asked all states to reject proposals for dolphinariums either by private parties or by government agencies, asking them not to allow import or capture of cetacean species and their use for commercial entertainment, and private or public exhibition.

In India, the Gangetic Dolphin and Snubfin Dolphin are protected species as per the Indian Wildlife (Protection) Act, 1972. The government has also declared Gangetic Dolphin as the national aquatic animal

Various animal protection organisation under the banner of Federation of Indian Animal Protection Organisations (FIAPO), has campaigned in the country to ban the establishment of dolphinariums.

6.9 PROHIBITION OF REMOVAL OF SHARK FINS IN THE SEA

With a view to stop the inhuman hunting of sharks and to enable the enforcement agencies to monitor the illegal hunting/poaching of the species of Sharks, Rays and Skates (Elasmobranchs) listed in Schedule I of the Wild Life (Protection) Act, 1972, Minister of for Environment and Forests has approved a policy for prohibiting the removal of shark fins on board a vessel in the sea.

The policy prescribes that any possession of shark fins that are not naturally attached to the body of the shark, would amount to "hunting" of a Schedule I species. The Policy calls for concerted action and implementation by the concerned State Governments through appropriate legislative, enforcement and other measures.

They play an important the role in maintenance of the marine ecosystem like tigers and leopards in the forests. India is known to be home to about 40-60 species of sharks. However, the population of some of these have declined over the years due to several reasons including over exploitation and unsustainable fishing practices.

Due to high demand of shark fines in the shark fin-soup industry, it has been reported that the fins of the sharks captured in the mid sea are removed on the vessel and the de finned sharks are thrown back in the sea to die. This has resulted in in-human killing of large number of sharks and further decimated the population of Schedule I species.

This practice prevailing on board the shipping vessels has led to difficulties in enforcement of provisions of Wild Life (Protection) Act, 1972 as it becomes difficult to identify the species of sharks from the fins alone, without the corresponding carcass, from which the fins have been detached.

6.10 COST OF ENVIRONMENTAL DEGRADATION IN INDIA

The annual cost of environmental degradation in India is about Rs. 3.75 trillion, or 5.7% of India's 2009 gross domestic product (GDP), according to a report released by the World Bank.

The impact of outdoor air pollution on GDP is the highest and accounts for 1.7% of the GDP loss, said the report. Indoor air pollution is the second-biggest offender and costs India 1.3% of GDP.

"The higher costs for outdoor/indoor air pollution are primarily driven by an elevated exposure of the young and productive urban population to particulate matter pollution that results in a substantial cardiopulmonary and chronic obstructive pulmonary disease (heart ailments) mortality load among adults," the report said.

The study, titled Diagnostic Assessment of Select Environmental Challenges in India, has taken into account environmental damage in India from urban air pollution, including particulate matter and lead; inadequate water supply; poor sanitation and hygiene; and indoor air pollution. Other factors that contribute to the loss include damage to natural resources because of worsening agricultural output because of an increase in soil salinity, water logging and soil erosion; rangeland degradation; deforestation and natural disasters.

"Environmental pollution, degradation of natural resources, natural disasters and inadequate environmental services, such as improved water supply and sanitation, impose costs to society in the form of ill health, lost income, and increased poverty and vulnerability," the report said.

A significant portion of diseases caused by poor water supply, sanitation and hygiene affect children younger than five, the report said. It attributed 23% of child mortality in the country to environmental degradation.

Following the concept of growing economically now and cleaning up later will not be environmentally sustainable for the country in the long run, said the lead author of the report.

The possible policy options to reduce particulate matter pollution could be incentivizing technology upgradation, securing efficiency improvements, strengthening enforcement and enhancing technology and efficiency standards.

Steps taken by the Indian Government for control air pollution

- formulation of a Comprehensive Policy for Abatement of Pollution,
- supply of improved auto-fuel,
- tightening of vehicular and industrial emission norms,
- mandatory environmental clearance for specified industries,
- management of municipal, hazardous and bio-medical wastes,
- promotion of cleaner technologies,
- strengthening the network of air quality monitoring stations,
- assessment of pollution load,
- source apportionment studies,
- preparation and implementation of action plans for major cities & critically polluted areas,
- Public awareness.

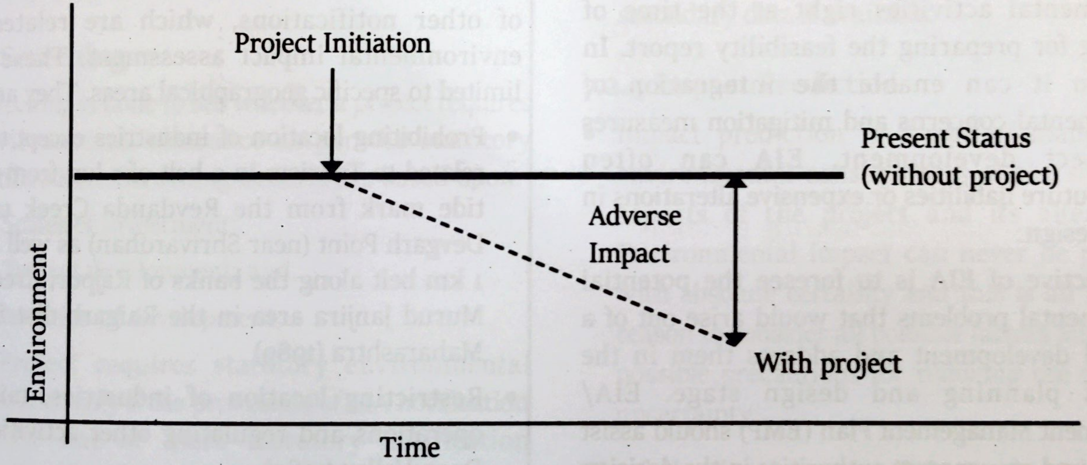
CHAPTER - 7

ENVIRONMENTAL IMPACT ASSESSMENT

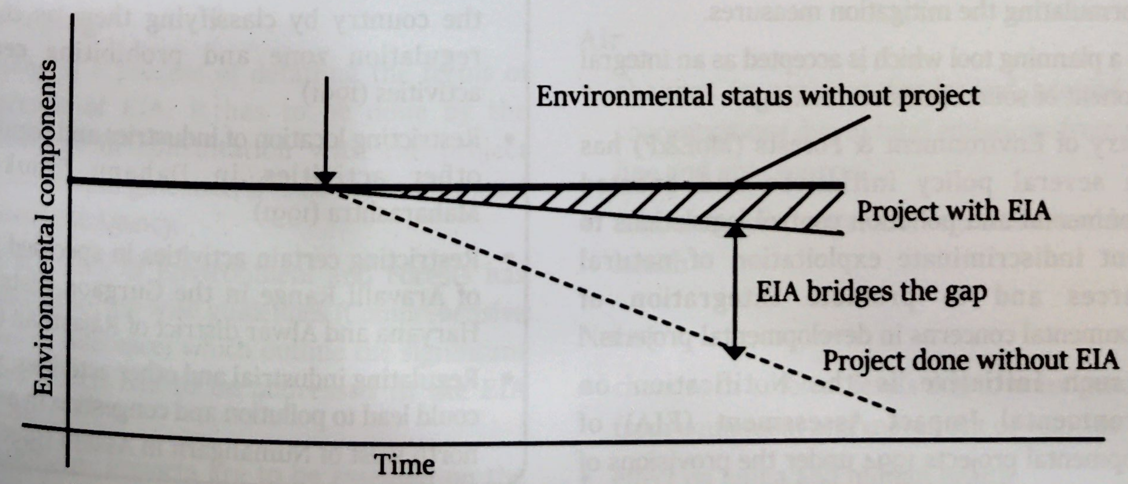
Environmental Protection and Sustainable Development has been the cornerstones of the policies and procedures governing the industrial and other developmental activities in India.

The Need for EIA

- Every anthropogenic activity has some impact on the environment. More often it is harmful to the environment than benign. However, mankind as



(a) Anticipated environment impact of development project.



(b) Environent impact rectification after EIA

it is developed today cannot live without taking up these activities for his food, security and other needs. Consequently, there is a need to harmonise developmental activities with the environmental concerns. It is desirable to ensure that the development options under consideration are sustainable. In doing so, environmental consequences must be characterised early in the project cycle and accounted for in the project design.

Environmental impact assessment (EIA)

Environmental impact assessment (EIA) is one of the tools available with the planners to achieve the goal of harmonising development activities with the environmental concerns.

EIA integrates the environmental concerns in the developmental activities right at the time of initiating for preparing the feasibility report. In doing so it can enable the integration of environmental concerns and mitigation measures in project development. EIA can often prevent future liabilities or expensive alterations in project design.

The objective of EIA is to foresee the potential environmental problems that would arise out of a proposed development and address them in the project's planning and design stage. EIA/ Environment Management Plan (EMP) should assist planners and government authorities in the decision making process by identifying the key impacts/issues and formulating the mitigation measures.

EIA is a planning tool which is accepted as an integral component of sound decision-making.

Ministry of Environment & Forests (MoE&F) has taken several policy initiatives and enacted environmental and pollution control legislations to prevent indiscriminate exploitation of natural resources and to promote integration of environmental concerns in developmental projects.

One such initiative is the Notification on Environmental Impact Assessment (EIA) of developmental projects 1994 under the provisions of Environment (Protection) Act, 1986.

7.1. INDIAN POLICIES REQUIRING EIA

- The environmental impact assessment in India was started in 1976-77 when the Planning Commission asked the then Department of Science and Technology to examine the river-valley projects from environmental angle. This was subsequently extended to cover those projects, which required approval of the Public Investment Board. These were administrative decisions, and lacked the legislative support. The Government of India enacted the Environment (Protection) Act on 1986. To achieve the objectives of the Act, one of the decisions that were taken is to make environmental impact assessment statutory.

Besides EIA, the Government of India under Environment (Protection) Act 1986 issued a number of other notifications, which are related to environmental impact assessment. These are limited to specific geographical areas. They are

- Prohibiting location of industries except those related to Tourism in a belt of 1 km from high tide mark from the Revdanda Creek up to Devgarh Point (near Shrivardhan) as well as in 1 km belt along the banks of Rajpuri Creek in Murud Janjira area in the Raigarh district of Maharashtra (1989)
- Restricting location of industries, mining operations and regulating other activities in Doon Valley (1989)
- Regulating activities in the coastal stretches of the country by classifying them as coastal regulation zone and prohibiting certain activities (1991)
- Restricting location of industries and regulating other activities in Dahanu Taluka in Maharashtra (1991)
- Restricting certain activities in specified areas of Aravalli Range in the Gurgaon district of Haryana and Alwar district of Rajasthan (1992)
- Regulating industrial and other activities, which could lead to pollution and congestion in an area north west of Numaligarh in Assam (1996)

7.2 THE EIA CYCLE AND PROCEDURES

The EIA process in India is made up of the following phases:

- Screening
- Scoping
- Baseline data collection
- Impact prediction
- Assessment of alternatives, delineation of mitigation measures and environmental impact statement
- Public hearing
- Environment Management Plan
- Decision making
- Monitoring the clearance conditions

7.2.1 Screening

- Screening is done to see whether a project requires environmental clearance as per the statutory notifications. Screening Criteria are based upon:
    - Scales of investment;
    - Type of development; and,
    - Location of development.
- A Project requires statutory environmental clearance only if the provisions of EIA notification and/or one or more statutory notification mentioned in Box 1 cover it

7.2.2 Scoping

- Scoping is a process of detailing the terms of reference of EIA. It has to be done by the consultant in consultation with the project proponent and guidance, if need be, from Impact Assessment Agency.
- The Ministry of Environment and Forests has published sector-wise guidelines (Comprehensive terms of reference) which outline the significant issues which has to be addressed in the EIA studies.
- Quantifiable impacts are to be assessed on the basis of magnitude, prevalence, frequency and duration and non-quantifiable impacts (such as aesthetic or recreational value), significance is commonly determined through the socio-economic criteria.
- After the areas, where the project could have significant impact, are identified, the baseline status of these should be monitored. And then the likely changes in these on account of the construction and operation of the proposed project should be predicted.

7.2.3 Baseline Data

- Baseline data describes the existing environmental status of the identified study area. The site-specific primary data should be monitored for the identified parameters and supplemented by secondary data if available.

7.2.4 Impact Prediction

- Impact prediction is a way of mapping the environmental consequences of the significant aspects of the project and its alternatives. Environmental impact can never be predicted with absolute certainty and this is all the more reason to consider all possible factors and take all possible precautions for reducing the degree of uncertainty.

The following impacts of the project should be assessed:

Air

- changes in ambient levels and ground level concentrations due to total emissions from point, line and area sources
- effects on soils, materials, vegetation, and human health

Noise

- changes in ambient levels due to noise generated from equipment and movement of vehicles
- effect on fauna and human health

Water

- availability to competing users
- changes in quality
- sediment transport
- ingress of saline water

Land

- changes in land use and drainage pattern
- changes in land quality including effects of waste disposal
- changes in shoreline/riverbank and their stability

Biological

- deforestation/tr
- ee-cutting and shrinkage of animal habitat.
- impact on fauna and flora (including aquatic species if any) due to contaminants/pollutants
- impact on rare and endangered species, endemic species, and migratory path/route of animals.

Impact on breeding and nesting grounds

Socio-Economic

- impact on the local community including demographic changes.

Impact on economic status

- impact on human health.
- impact of increased traffic

7.2.5 Assessment of Alternatives, Delineation of Mitigation Measures and Environmental Impact Assessment Report

- For every project, possible alternatives should be identified and environmental attributes compared. Alternatives should cover both project location and process technologies. Alternatives should consider no project option also. Alternatives should then be ranked for selection of the best environmental option for optimum economic benefits to the community at large.
- Once alternatives have been reviewed, a mitigation plan should be drawn up for the selected option and is supplemented with an Environmental Management Plan (EMP) to guide the proponent towards environmental improvements. The EMP is a crucial input to monitoring the clearance conditions and therefore details of monitor should be included in the EMP.
- An EIA report should provide clear information to the decision-maker on the different environmental scenarios without the project, with the project and with project alternatives. Uncertainties should be clearly reflected in the EIA report.

7.2.6 Public Hearing

- Law requires that the public must be informed and consulted on a proposed development after the completion of EIA report.
- Any one likely to be affected by the proposed project is entitled to have access to the Executive Summary of the EIA. The affected persons may include:
  - bonafide local residents;
  - local associations;
  - environmental groups: active in the area
  - any other person located at the project site / sites of displacement
  - They are to be given an opportunity to make oral/written suggestions to the State Pollution Control Board.

7.2.7. Environment Management Plan

Environment Management Plan should include:

- Delineation of mitigation and compensation measures for all the identified significant impacts
- Delineation of unmitigated impacts
- Physical planning including work programme, time schedule and locations for putting mitigation and compensation systems in place
- Delineation of financial plan for implementing the mitigation measures in the form of budgetary

estimates and demonstration of its inclusion in the project budget estimates.

7.2.8 Decision Making

- Decision making process involve consultation between the project proponent (assisted by a consultant) and the impact assessment authority (assisted by an expert group if necessary)
- The decision on environmental clearance is arrived through a number of steps including evaluation of EIA and EMP.

Monitoring the Clearance Conditions

onitoring should be done during both construction and operation phases of a project. This is not only to ensure that the commitments made are complied with but also to observe whether the predictions made in the EIA reports were correct or not. Where the impacts exceed the predicted levels, corrective action should be taken. Monitoring will enable the regulatory agency to review the validity of predictions and the conditions of implementation of the Environmental Management Plan (EMP).

Salient Features of 2006 Amendment

Environment Impact Assessment Notification of 2006 has decentralised the environmental clearance projects by categorizing the developmental projects in two categories, i.e., Category A and Category B.

'Category A' projects are appraised at national level by Impact Assessment Agency (IAA) and the Expert Appraisal Committee (EAC) and Category B projects are apprised at state level.

State Level Environment Impact Assessment Authority (SEIAA) and State Level Expert Appraisal Committee (SEAC) are constituted to provide clearance to Category B process.

After 2006 Amendment the EIA cycle comprises of four stages

1. Screening
2. Scoping
3. Public hearing
4. Appraisal

Category A projects require mandatory environmental clearance and thus we do not undergo the screening process.

Category B projects undergoes screening process and they are classified into two types.

1. Category B_1 projects (Mandatory requires EIA).
2. Category B_2 projects (Do not require EIA).

Thus Category A projects and Category B_1 projects undergo the complete EIA process whereas Category B_2 projects are excluded from complete EIA process.

Environment Impact Assessment (EIA) Notification 2020

Under the Environment (Protection) Act, 1986, the Ministry of Environment, Forest and Climate Change (MoEF&CC) published the draft Environment Impact Assessment (EIA) Notification 2020 to replace the 2006 notification.

Some of the key provisions of the 2020 EIA Notification include:

- A reduction in the public hearing period from 30 to 20 days.
- The classification of projects, such as into A, B1, and B2, are exempted from public scrutiny.
- Changes in post-clearance compliance reporting, shifting from semi-annual to annual submissions.
- Requirement for project proponents to prepare the EIA report exclusively.
- The omission of reporting violations and non-compliance by the public.
- Introduction of post-facto clearance, allowing projects operating without prior environmental clearance to apply for it.

Imposition of penalties on firms found violating their establishment terms.

7.3 COMPONENTS OF EIA

- The difference between Comprehensive EIA and Rapid EIA is in the time-scale of the data supplied.

Rapid EIA is for speedier appraisal process. While both types of EIA require inclusion/ coverage of all significant environmental impacts and their mitigation, Rapid EIA achieves this through the collection of one season (other than monsoon) data only to reduce the time required where comprehensive EIA collects data from all four seasons.

- Rapid EIA is acceptable if it does not compromise on the quality of decision-making. The review of Rapid EIA submissions will show whether a comprehensive EIA is warranted or not.
- It is, therefore, clear that the submission of a professionally prepared Comprehensive EIA in the first instance would generally be the more efficient approach. Depending on nature, location and scale of the project EIA report should contain all or some of the following components.

Air Environment

- Determination of impact zone (through a screening model) and developing a monitoring network
- Monitoring the existing status of ambient air quality within the impacted region (7-10 km from the periphery) of the proposed project site
- Monitoring the site-specific meteorological data, viz. wind speed and direction, humidity, ambient temperature and environmental lapse rate
- Estimation of quantities of air emissions including fugitive emissions from the proposed project
- Identification, quantification and evaluation of other potential emissions (including those of vehicular traffic) within the impact zone and estimation of cumulative of all the emissions/ impacts
- Prediction of changes in the ambient air quality due to point, line and areas source emissions through appropriate air quality models
- Evaluation of the adequacy of the proposed pollution control devices to meet gaseous emission and ambient air quality standards
- Delineation of mitigation measures at source, path ways and receptor

Noise Environment

- Monitoring the present status of noise levels within the impact zone, and prediction of future noise levels resulting from the proposed project and related activities including increase in vehicular movement
- Identification of impacts due to any anticipated rise in noise levels on the surrounding environment
- Recommendations on mitigation measures for noise pollution

Water Environment

- Study of existing ground and surface water resources with respect to quantity and quality within the impact zone of the proposed project
- Prediction of impacts on water resources due to the proposed water use/pumping on account of the project
- Quantification and characterisation of waste water including toxic organic, from the proposed activity
- Evaluation of the proposed pollution prevention and wastewater treatment system and suggestions on modification, if required
- Prediction of impacts of effluent discharge on the quality of the receiving water body using appropriate mathematical/simulation models
- Assessment of the feasibility of water recycling and reuse and delineation of detailed plan in this regard

Biological Environment

Survey of flora and fauna clearly delineating season and duration.

- Assessment of flora and fauna present within the impact zone of the project
- Assessment of potential damage to terrestrial and aquatic flora and fauna due to discharge of effluents and gaseous emissions from the project

- Assessment of damage to terrestrial flora and fauna due to air pollution, and land use and landscape changes
- Assessment of damage to aquatic and marine flora and fauna (including commercial fishing) due to physical disturbances and alterations
- Prediction of biological stresses within the impact zone of the proposed project
- Delineation of mitigation measures to prevent and / or reduce the damage.

Land Environment

- Studies on soil characteristics, existing land use and topography, landscape and drainage patterns within the impact zone
- Estimation on impacts of project on land use, landscape, topography, drainage and hydrology
- Identification on potential utility of treated effluent in land application and subsequent impacts
- Estimation and Characterisation of solid wastes and delineation of management options for minimisation of waste and environmentally compatible disposal

Socio-economic and Health Environment

- Collection of demographic and related socio-economic data
- Collection of epidemiological data, including studies on prominent endemic diseases (e.g. fluorosis, malaria, fileria, malnutrition) and morbidity rates among the population within the impact zone
- Projection of anticipated changes in the socio-economic and health due to the project and related activities including traffic congestion and delineation of measures to minimise adverse impacts
- Assessment of impact on significant historical, cultural and archaeological sites/places in the area
- Assessment of economic benefits arising out of the project
- Assessment of rehabilitation requirements with special emphasis on scheduled areas, if any.

Risk Assessment

- Hazard identification taking recourse to hazard indices, inventory analysis, dam break probability, Natural Hazard Probability etc.
- Maximum Credible Accident (MCA) analysis to identify potential hazardous scenarios
- Consequence analysis of failures and accidents resulting in fire, explosion, hazardous releases and dam breaks etc.
- Hazard & Operability (HAZOP) studies
- Assessment of risk on the basis of the above evaluations
- Preparation of an onsite and off site (project affected area) Disaster Management Plan

Environment Management Plan

- Delineation of mitigation measures including prevention and control for each environmental component and rehabilitation and resettlement plan.
- Delineation of monitoring scheme for compliance of conditions
- Delineation of implementation plan including scheduling and resource allocation

Do you know?

Environment Ministry to create 'urban forests' in 200 cities to increase green cover. 'Urban Forestry Scheme' launched in Pune, to create an 'urban jungle' on about 80 acres of land.

7.4. KEY ELEMENTS OF AN INITIAL PROJECT DESCRIPTION AND SCOPING

- The key environmental issues to be considered in relation to a project characteristics are discussed in Sectoral Guidelines published by MoEF from time to time.
- An Initial Project Description (IPD) should at the very least, provide the reviewer with all the

information necessary to enable project screening and scoping.

Specific information that must be covered by the IPD includes:

- Location/current land use along with contours and whether it conforms to the development plans proposed for that area
- Details of proposed project activity including the project cost
- Outlining the key project elements during the pre-construction, the construction and the operation phases etc. as per the list of documents to be attached with the questionnaire
- The IPD may also include.
- Off-site activities
- Associated activities
- Expected project induced activities
- Project activities as PERT chart and process as a flow chart delineating unit processes with input-output.

- This would facilitate the reviewers task. The project proponent after suitable scoping should provide environmental information for consideration in detailed EIA. The reviewer while assessing the report should focus on the crucial aspects involving project location and characteristics.

7.4.1 Project Location(s)

- The site(s) selection can be an effective approach in minimising the requirement of mitigation measures.
- Proposed project locations should be reviewed based upon regulatory and non-regulatory criteria.
- Project siting restrictions depend on the sensitivity of the surrounding environment. Sensitivity should be assessed in relation to proximity of the project to the places/sites listed in the identified ecologically sensitive zones (ESZ) notified by MOEF.

The siting criteria delineated by MoEF include:

I. As far as possible prime agricultural land/forest land may not be converted into an industrial site

II. Land acquired should be minimum but sufficient to provide for a green belt wherein the treated wastewater, if possible/suitable, could be utilised from wastewater treatment systems

III. Enough space may be provided for storing solid wastes. The space and the waste can be made available for possible reuse in future

IV. Layout and form of the project must conform to the landscape of the area without unduly affecting the scenic features of that place

V. Associated township of the project if any to be created must provide for space for phyto- graphic barrier between the project and the township and should take into account predominant wind direction.

In addition the following distances should be maintained:

- **Coastal Areas:** at least 1/2 km from the high tide line (within 0.5 km of High Tide Line (HTL), specified activities as per CRZ notification, 1991 are permitted) (The HTL is to be delineated by the authorised agency only.)
- **Estuaries:** At least 200 metres from the estuary boundaries
- **Flood Plains of the Riverine systems:** at least 500 metres from flood plain or modified flood plain or by flood control systems
- **Transport/Communication System:** at least 500 metres from highway and railway
- Major Settlements (3,00,000 population) at least 25 km from the projected growth boundary of the settlement

In addition to the siting criteria listed above, the proposed project location should be reviewed in relation to the following salient issues:

- Ambient air, water and noise quality standards
- Critically polluted areas
- Natural disaster prone areas

- Ecologically sensitive areas
- Availability of water and other critical infrastructures like electricity, roads with adequate width and capacity

7.4.2. Procedure For Public Hearing

(1) Process of Public Hearing: -

Whoever apply for environmental clearance of projects, shall submit to the concerned State Pollution Control Board.

(2) Notice of Public Hearing: -

i. The State Pollution Control Board shall cause a notice for environmental public hearing which shall be published in at least two newspapers widely circulated in the region around the project, one of which shall be in the vernacular language of the locality concerned. State Pollution Control Board shall mention the date, time and place of public hearing. Suggestions, views, comments and objections of the public shall be invited within thirty days from the date of publication of the notification.

ii. All persons including bona fide residents, environmental groups and others located at the project site/sites of displacement/sites likely to be affected can participate in the public hearing. They can also make oral/written suggestions to the State Pollution Control Board.

(3) Composition of public hearing panel: -

The composition of Public Hearing Panel may consist of the following, namely: -

i. Representative of State Pollution Control Board;

ii. District Collector or his nominee;

iii. Representative of State Government dealing with the subject;

iv. Representative of Department of the State Government dealing with Environment;

v. Not more than three representatives of the local bodies such as Municipalities or panchayats;

vi. Not more than three senior citizens of the area nominated by the District Collector.

Do you know?

Environmental Information System (ENVIS), a Central Sector Scheme of the Ministry has been implemented since 1982. The purpose of the scheme is to integrate country-wide efforts in environmental information collection, collation, storage, retrieval and dissemination through ENVIS websites, which are dedicated to different interesting themes.

7.5 ENVIRONMENTAL IMPACT ASSESSMENT IN THE INDIAN SYSTEM - DRAWBACKS AND RECOMMENDATIONS

7.5.1. Draw Backs

Applicability:

1. There are several projects with significant environmental impacts that are exempted from the notification either because they are not listed in schedule 1, or their investments are less than what is provided for in the notification.

Composition of expert committees and standards:

1. It is being found that the team formed for conducting EIA studies is lacking the expertise in various fields such as environmentalists, wild life experts, Anthropologists and Social Scientists (to study the social impact of the project).
2. There is a lack of exhaustive ecological and socio-economic indicators for impact assessment.

Public hearing:

1. Public comments are not taken into account at the early stage, which often leads to conflict at the later stage of project clearance.
2. A number of projects with significant environmental and social impacts have been

excluded from the mandatory public hearing process.

3. The documents which the public are entitled to are seldom available on time.
4. The data collectors do not pay respect to the indigenous knowledge of local people.

Quality:

1. One of the biggest concerns with the environmental clearance process is related to the quality of EIA report that are being carried out. The reports are generally incomplete and provided with false data.
2. EIA reports ignore several aspects while carrying out assessments and significant information is found to omitted.
3. Many EIA report are based on single season data and are not adequate to determine whether environmental clearance should be granted. All this makes the entire exercise contrary to its very intent.
4. As things stand today, it is the responsibility of the project proponent to commission the preparation of the EIA for its project. The EIA is actually funded by an agency or individual whose primary interest is to procure clearance for the project proposed. There is little chance that the final assessment presented is un biased, even if the consultant may provide an unbiased assessment that is critical of the proposed project. Some times it is found that a consultancy which is working in the project area has no specialization in the concerned subject. For example for the preparation of EIA report of the proposed oil exploration in coast of Orissa by the reliance group has been given to the life science Dept of Berhampur university which has no expertise on the study of turtles and its life cycle.
5. The EIA document in itself is so bulky and technical, which makes it very difficult to decipher so as to aid in the decision making process.
6. There are so many cases of fraudulent EIA studies where erroneous data has been used, same facts used for two totally different places etc. This is due to the lack of a centralized baseline data bank, where such data can be crosschecked.
7. There is no accreditation of EIA consultants, therefore any such consultant with a track record of fraudulent cases cannot be held liable for discrepancies. It is hard to imagine any consultant after being paid lakh of rupees, preparing a report for the project proponents, indicating that the project is not viable.
7. In nearly every case, the consultants try to interpret and tailor the information looking for ways and means to provide their clients with a report that gives them their moneys worth.

Monitoring, compliance and institutional arrangements:

1. Often, and more so for strategic industries such as nuclear energy projected, the EMPs are kept confidential for political and administrative reasons
2. Details regarding the effectiveness and implementation of mitigation measures are often not provided.
3. Emergency preparedness plans are not discussed in sufficient details and the information not disseminated to the communities.

7.5.2. Recommendations

1. Independent EIA Authority
2. Sector wide EIA s needed
3. Creation of an information desk
4. Creation of a centralized baseline data bank
5. Dissemination of all information related to projects from notification to clearance to local communities and general public

Applicability:

1. All those projects where there is likely to be a significant alternation of ecosystems need to go through the process of environmental clearance, without exception.

2. No industrial developmental activity should be permitted in ecologically sensitive areas.

Public hearing:

1. Public hearings should be applicable to all hitherto exempt categories of projects which have environmental impacts.

Quality:

1. The focus of EIA needs to shift from utilization and exploitation of natural resources to conservation of natural resources.
2. At present EIA reports are extremely weak when it comes to assessment of biological diversity of a project area and the consequent impacts on it. This gap needs to be plugged through a specific guidelines and through necessary amendments.
3. The checklist needs to include impacts on agricultural biodiversity, biodiversity related traditional knowledge and live hoods.
4. All EIA reports should clearly state what are the adverse impacts that a proposed projects will have. This should be a separate chapter and not hidden within technical details.
5. The sub components or subsidiary reports of EIA reports (e.g. Assessments of Biodiversity impacts done by a sub consultant) should be made publicly accessible as stand alone reports with the EIA. This should be available on the websites of the MOEF.
6. EIAs should be based on full studies carried out over at least one year. Single season data on environmental parameters like biodiversity, as is being done for several rapid assessments is not adequate to gain understanding of the full impact of the proposed project.
7. It is critical that the preparation of an EIA is completely independent of the project proponent. One option for this could be the creation of a central fund for the EIAs which contains fees deposited by project proponents while seeking that an EIA be done for their proposed project.
7. State and central governments should maintain a list of credible, independent and competent agencies that can carry out EIAs. similarly the EIA consultant those are making false reports should be black listed.
9. A national level accreditation to environment consultancy should be adopted

Grant of clearance:

1. The notification needs to make it clear that the provision for site clearance does not imply any commitment on the part of the impact Assessment agency to grant full environmental clearance.
2. The prior informed consent of local communities and urban wards or residents association needs to be made mandatory before the grant of environmental clearance. The consent should be from the full general body.
3. The language used for specifying conditions of clearance must be clear and specific.

Composition of expert committees:

1. The present executive committees should be replaced by expert's people from various stakeholder groups, who are reputed in environmental and other relevant fields.
2. The process of selection of those committees should be open and transparent. The minutes, decisions and advice by these committee should be open to public.

Monitoring, compliance and institutional arrangements:

1. The EIA notification needs to build within it an automatic withdrawal of clearance if the conditions of clearance are being violated, and introduce more stringent punishment for non-compliance. At present the EIA notification limits itself to the stage when environmental clearance is granted.
2. The MOEF should set up more regional offices with advisory Expert committees, each with smaller areas of jurisdiction, to effectively monitor the compliance of clearance conditions.
3. A robust monitoring mechanism should be established by the state department to address

compliance of both sets of clearance conditions together and to take punitive action against the project proponent in case of non-compliance.

4. Local communities should be brought in to the formal monitoring and reporting process of the compliance of conditions presently done by the regional offices of the MOEF.

Redressal:

1. The composition of the NGT needs to be changed to include more judicials from the field of environment.
2. Citizen should be able to access the authority for redressal of all violation of the EIA notification as well as issues relating to non-compliance.

Capacity building:

NGOs, civil society groups and local communities need to build their capacities to use the EIA notification towards better decision making on projects that can impact their local environments and live hoods. Capacities can be built to proactively and effectively use the notification rather than respond in a manner that is seen as negative or unproductive.

7.5.3. List of Environmentally Sensitive Places

- Religious and historic places
- Archaeological monuments/sites
- Scenic areas
- Hill resorts/mountains/ hills
- Beach resorts
- Health resorts
- Coastal areas rich in corals, mangroves, breeding grounds of specific species
- Estuaries rich in mangroves, breeding ground of specific species
- Gulf areas
- Biosphere reserves
- National park and wildlife sanctuaries
- Natural lakes, swamps Seismic zones tribal Settlements
- Areas of scientific and geological interests
- Defense installations, specially those of security importance and sensitive to pollution
- Border areas (international)
- Airport
- Tiger reserves/elephant reserve/turtle nestling grounds
- Habitat for migratory birds
- Lakes, reservoirs, dams
- Streams/rivers/estuary/seas
- Railway lines
- Highways
- Urban agglomeration

Do you know?

The criteria followed for specification of a community as a Scheduled Tribe are (i) indications of primitive traits, (ii) distinctive culture, (iii) geographical isolation, (iv) shyness of contact with the community at large, and (v) backwardness.

7.5.4. Environment Supplement Plan (Esp)

- An Environmental Supplemental Plan (ESP) is an environmentally beneficial project or activity that is not required by law, but that an alleged violator of Environmental Impact Assessment Notification, 2006 agrees to undertake as part of the process of environmental clearance.
- "Environmentally beneficial" means an Environmental Supplemental Plan must remediate, improve, protect the environment or reduce risks to public health or the environment.

Proposals under ESP

- ESP would allow violator companies to continue their activities by paying a financial penalty.
- This would then be invested in an "environmentally beneficial project or activity" for an affected target group of stakeholders.

Advantages

- Many developmental projects have been currently been stalled to non-compliance with EIA regime or for preparing an improper EIA. ESP would enable reviving these projects.
- The "Bad Loans" issue currently plaguing the Banking sector can be substantially resolved through reviving the stalled projects.

Disadvantages

- ESP is a clever attempt to legalize EIA violation and gain corporate confidence, thereby allowing violator to damage the environment and circumvent the EIA process.
- Among all cases filed in the National Green Tribunal (NGT), around 41% are cases where the NGT found faults with an EIA assessment. Thus, EIA violation is a major in developmental projects. Allowing such violators to carry on, defeats the ultimate purpose of EIA.
- Many experts argue that this indirectly allows pardoning of violations. Rather than building upon the "Polluters Pay Principle", the ESP looks like an attempt to promote corporate development by using a contradictory "Pay and Pollute" principle.
- MoEFCC stated the notification has legal basis in two judgments, one by the NGT and the other by the Jharkhand High Court. But neither of the two judgments condones EIA violations to be regularized post facto nor does it prescribe a way out of these for violators.
- Valuation of environmental loss cannot be just compensated by pecuniary payment by the violator.
- Whether the fine amount would be collected properly and utilized for restoration is doubtful. No mechanism has been proposed to utilize the collected funds.
- ESP provides an escape mechanism to violators. Instead of following the path of an EIA clearance, they can get away by paying a penalty through specific investment activities.

7.5.5. PARIVESH (Pro-Active and Responsive facilitation by Interactive, Virtuous and Environmental Single-window Hub)

- PARIVESH is a Single-Window Integrated Environmental Management System. Key features include single registration and single sign-in for all types of clearances (i.e. Environment, Forest, Wildlife and CRZ), unique-ID for all types of clearances required for a particular project and a single Window interface for the proponent to submit applications for getting all types of clearances (i.e. Environment, Forests, Wildlife and CRZ clearances).

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